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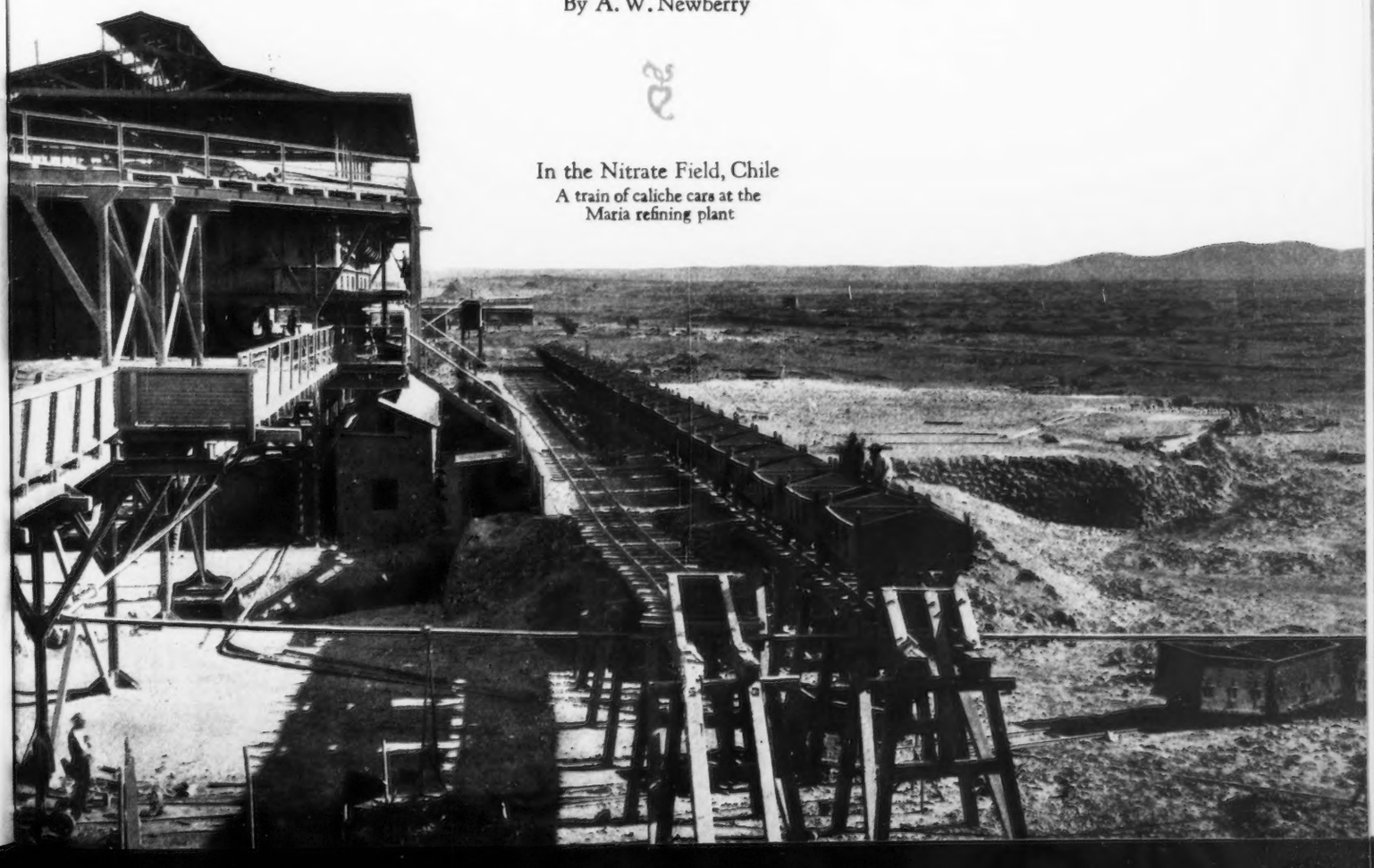
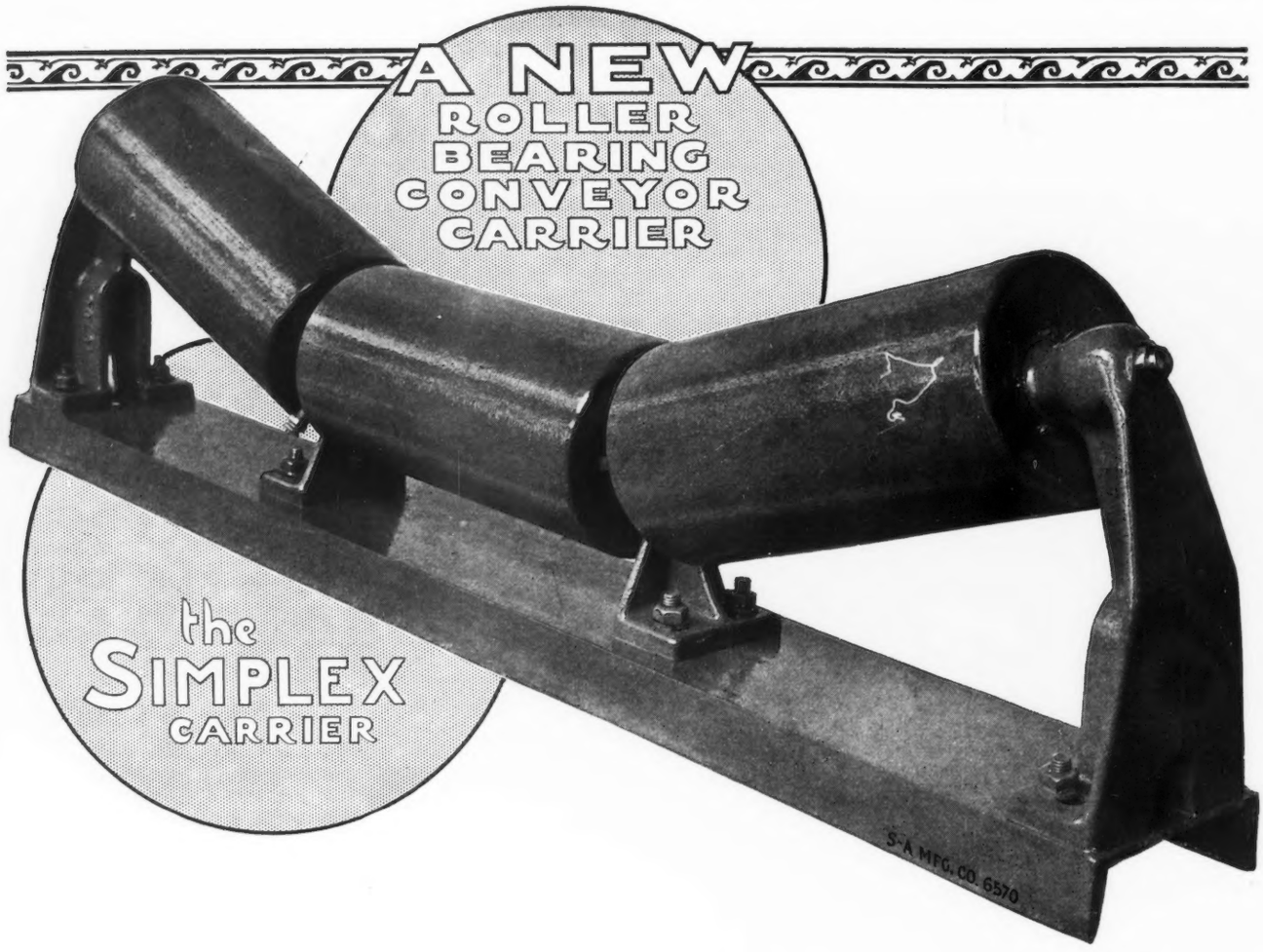


In the Nitrate Field, Chile
A train of caliche cars at the Maria refining plant



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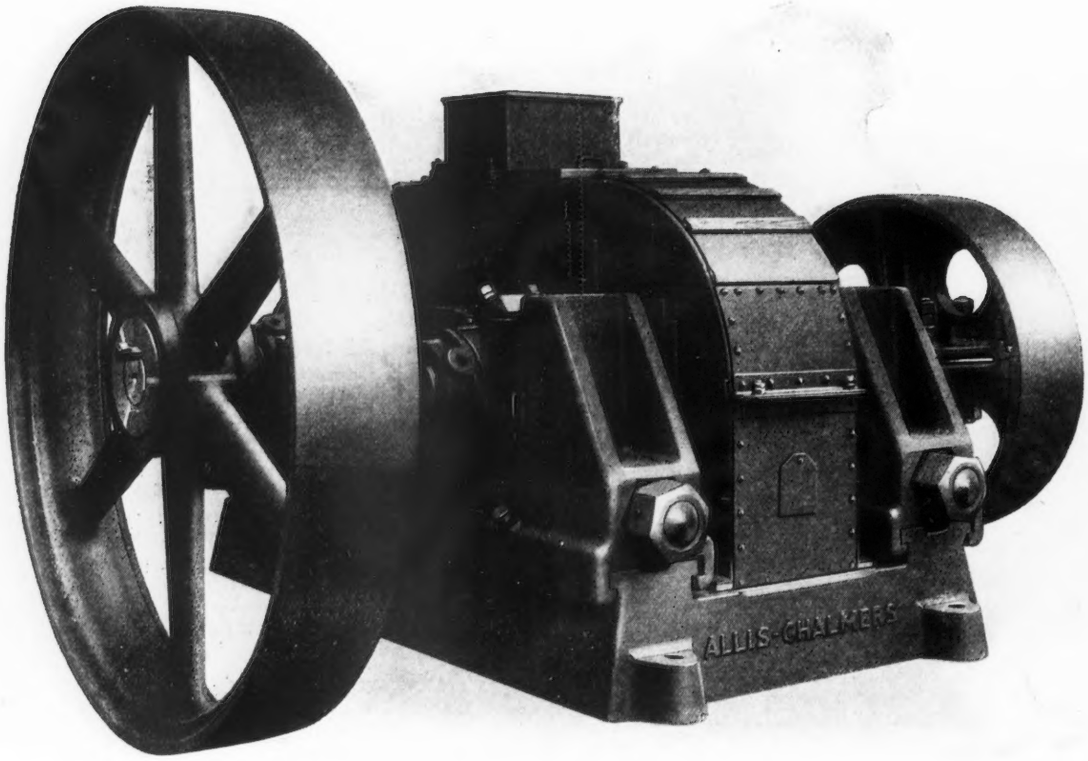

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ENGINEERING AND
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JOSIAH EDWARD SPURR, Editor

Volume 123 New York, January 8, 1927 *Number* 2

Mineral Resources of the British Empire

IN AN EXCELLENT and scholarly address in November, before the Royal Society of Arts, in London, Sir Thomas Holland surveyed the raw-material resources of the British Empire. Coming to the question of mineral supplies, he refers as an example which should be followed, to the war-time and post-war inquiries in the United States into the statistical and economic position of the United States with reference to mineral supplies—an inquiry begun by the War Minerals Investigation service, associated with the Bureau of Mines, and continued by the Mining and Metallurgical Society of America's Committee on Foreign and Domestic Mining Policy and a corresponding and co-operating committee of the Mining and Metallurgical Engineers:

"The precision and thoroughness with which the vital question of mineral needs in the United States is being treated gives us a lead which it would be dangerous for us to disregard. For this Empire the question of mineral supply is even more important than in America; for our chief manufacturing area and principal military base are in Great Britain, where we have only a fraction of the minerals that are now required and where we have already depleted some of the stocks that once we had."

As compared with the now well-known analyses of the surpluses and deficits of various essential minerals in the United States, Sir Thomas observed:

"We just know enough at present to say with some confidence that, as an Empire, but by no means in all parts of it, we can turn out more than we want of the raw materials required to meet our needs of aluminum, arsenic, cadmium, chrome, coal, cobalt, diamonds, gold, graphite, iron, manganese, mica, molybdenum, monazite, nickel, silver, tin, and tungsten. Of some of these we are the principal producers and apparently have an abundance for sale, such as cadmium, chrome, diamonds, gold, graphite, manganese, mica, molybdenum, monazite, nickel, tin, and tungsten, but we are obviously dependent on foreign sources for either a whole or a part of our normal requirements in some minerals, such as antimony, bismuth, potash, quicksilver, and possibly copper, lead, zinc, and phosphates."

He points out, however, that the geographical distribution of Colonies and Dominions with reference to the mother country, and the fiscal independence of the most important Dominions, render this summary less significant than in the case of the economically coherent United States. He observes:

"We may be a political unit, but we are still far from being an economic unit. The varied products of the United States can flow from one state to another without the interruption of fiscal barriers or port dues. . . . The last lesson touches all measures designed to remove barriers, political and fiscal, that interfere with freedom of transport within the Empire. The general tendency toward the federation of small political units and the concurrent fusion of independently formed commercial undertakings facilitate international agreements: it is a world movement that the British Empire must share."

The possible shortcomings of the British commonwealth of nations in copper, lead, zinc, and the phosphates are offset by the abundance of these materials produced by the United States; the deficiency of the United States in metals like nickel and tin is matched by the abundance of these materials in the possession of the commonwealth. International trade, exchanging a commodity one nation has in surplus for one that it needs, will always be necessary for the satisfaction of the world's industries and its best development, and its comparative freedom will be necessary to avoid economic and consequent political strain. Hence the removal of artificial barriers which impede such natural and necessary movements should so far as practicable be accomplished, not only between different parts of the British commonwealth, but between the nations of the Empire and the United States. We must expect that the merchants in the future, as in the past, will attempt to buy low and sell high, for that is the incentive of trade and industry; and commercial nations will continue to have some element of this same principle of driving an advantageous bargain. Nevertheless, the conviction is growing that the greatest prosperity of the part results from that of the whole. The United States has demonstrated that, and the British Empire has partly done so and will do so more definitely. And the principle has a broader application, which eventually will secure broader and broader economic co-operation between independent nations, and so tend to progressively eliminate poverty and the incentive toward war.

Mine Salting à la Mode

CERTAIN TYPES of properties and mining claim owners often display an ingenuous faith in their ability to trade. It is a human failing to underrate the other fellow. Southern California affords the latest novelty. It seems that mining engineers employed by Los Angeles County to appraise some mining claims within the confines of a proposed flood control dam, and the waters which it will confine, recently reported having found one nugget (presumably gold) not less than nine different times upon one claim. The engineers are stated to have said that any gold found during their examination went, by agreement, to the owner of the claim. One owner pointed out the best place to pan. The crafty mining engineers marked the gold nugget which they first found and were thus able to identify it as the same nugget, at the eighth successive time that it was discovered. Nuggets are getting scarce, and no doubt this was the underlying reason for the repeated use of the same nugget, although the claim owner in question very likely did not have the wherewithal to purchase a suite of nuggets for the purpose and relied too much upon the common failing of humanity.

The Position of Mercury

THE STATISTICAL POSITION of mercury among the industrial metals of the world has often been put forward in these pages; but since it is not yet generally understood, and since interested producers in many cases hold and promulgate pictures of the situation which do not correspond to a judicial survey, it is of interest to consider the recent bulletin of the Bureau of Mines by J. W. Furness covering the position of the metal for 1925, the first sentence of which bulletin reads: "The domestic consumer of mercury is becoming more and more dependent upon foreign sources of supply."

The excess of mercury exports from the United States, over imports, which prevailed previous to 1911, shifted in that year to an excess of imports, which has gradually increased in spite of the progressive working of lower and lower grade domestic ores, made possible by greatly reduced working costs and by a special protective tariff. In 1925 nearly 21,000 flasks (of 75 lb. each) were imported, while the domestic production was about 9,000 flasks. The average grade of domestic ores in 1925 was 0.5 per cent.

As to the foreign sources to which the United States must in the future look for its supplies of quicksilver, Mr. Furness concludes:

"To a consumer the present situation would seem to indicate that in order to supply the demand for mercury, the deposits of Spain which contain the largest known reserves will have to be drawn upon heavily. Of the two Italian fields, the Idria district is rapidly reaching exhaustion; the Monte Amiata district may be able to maintain its present rate of production for twenty years. The United States, once the largest producer of mercury, is now a minor contributor to the world's supply. As the world's consumption of mercury for the last twenty years (exclusive of the war) has been decreasing while the price has been rising, the present increased demand for storage batteries, meters, radio equipment, and general electrical uses, as well as the potential demand that probably will be created by the introduction of the Emmet vapor boiler, indicates that in order to meet this increase, or even to maintain the present rate of consumption, more mercury will have to come from Spain."

The effect of progressive exhaustion upon an ore deposit in bringing about the mining of lower and lower grade ores is indicated by the fact that the average tenor of ore treated in the Italian mines was 0.7 per cent, compared with 0.5 in the United States and 6 per cent in Spain.

The present United States import tariff of 25c. a pound on mercury was imposed in 1922; this amounts to $18.75 per flask. That this tariff, together with substantial operating economy, permitted a slight expansion of domestic production and increasing prices for the product, is shown by the increase from around 6,000 flasks in 1921 and 1922 to around 8,000 flasks in 1923, 10,000 flasks in 1924, and 9,000 flasks in 1925. Yet the production has never equaled the post-war years immediately preceding 1922, of 13,000 flasks in 1920, and 21,000 flasks in 1919. These years were periods of inflated post-war prices, which dropped perpendicularly from $81 (in New York) in 1920, to $45 in 1921. Since then each year has shown an upward climb, culminating in $83 in 1925.

Despite the fact that mercury has certain industrial uses not shared by other metals, on account of its low melting point and other qualities, the statistics show that the consumption has not kept pace with the increased consumption of many other industrial metals; but has, indeed, remained approximately static. The amount apparently consumed in the United States has varied little since 1911, in which year it was 27,000 flasks; in 1925 it was about 30,000 flasks. Total world production was between 90,000 and 95,000 flasks in 1922, 1923 and 1924, and was 104,000 in 1925. But the largest world production was made in 1896, of 126,000 flasks; and in 1881 and again in 1912 reached 122,000. Mr. Furness remarks:

"Since 1912 the price has in the main and except for the post-war slump been ascending and the world's consumption has been decreasing. . . . High prices not only tend to stimulate the production of the metal, but also to restrict consumption for certain purposes. With almost all other metals, a decrease in price has a tendency to greatly increase the consumption, but this relation between price and consumption is not so direct for mercury. The low value of the metal, in spite of the fact of its comparative rarity, is due to restricted demand. The uses of mercury are rather diversified, but the amount used to satisfy any of these demands is extremely small. In comparison with the quantities produced, mercury is the cheapest of metals, therefore the value of the total production is small."

The above situation suggests that as far as mercury is concerned the world is in an industrial position to "Take it or leave it." Neither the world's supply nor the United States consumption seems to have been seriously affected one way or other by the progressive increase in price from 1922 to 1925. A certain steady amount is required, at the necessary price paid: the amount going into manufactured articles is usually small and does not greatly affect the final cost of the product. It would appear, therefore, that the future supply of mercury, which will come increasingly from Spain, will be at a price largely determined by the cost of production rather than by the demand.

Mining Archæology

OLD PRACTICES AND CUSTOMS, their origin and development, make interesting studies. The translation by the Hoovers of "De Re Metallica" found its wide circle of readers on this account. The short series of articles on ancient mining and metallurgy by H. H. Manchester, which was published in these pages some years ago, was received with considerable favor. Since then have appeared Mr. Rickard's studies on the early uses of metals and on the ancient and primitive methods in the arts of winning and reducing them. Mr. Rickard's latest contribution along this line is in this issue. The methods he describes—those used by the Katanga natives in making and working copper—are primitive, indeed, but not ancient, if by "ancient" one means "B.C." Especially interesting is his account of wire drawing as practised by the Bayeke tribe. Another article of similar interest, that will appear this winter, is one by Mr. Sydney H. Ball, on turquoise mining in the Sinai Peninsula, a topic not hitherto discussed, but of considerable historical interest. It was in the region covered by Mr. Ball that the Egyptian rulers for over 2,000 years obtained their turquoise, much used in that early day for jewels and other purposes.

An Offering of Tin Stock

A RECENT OFFERING of 200,000 shares of the Patiño Mines & Enterprises Consolidated, for the first time floats an important issue of a tin-mining stock in the New York market. The present high price of tin and the geological outlook, indicating that tin will probably become scarcer than otherwise in the immediately succeeding years, whet the appetite of investors for a share in an industry for which the future seems so favorable. The fact that the United States is practically without tin supplies of its own, and has no hope of any being developed, even in the whole of North America, has led American capitalists to look with friendly interest upon foreign deposits. An effort was made to develop a tin-smelting industry in the United States, but one smelter was given up because of the export duty which was imposed on tin ore from the Malay Peninsula as a counter move to the establishing of this American smelting industry; other American smelting enterprises for treating Bolivian ores closed down on account of British competition.

The Guggenheim interests are dredging tin in the Malay Peninsula, some of the dredges of the Yukon Gold Co. having been transferred thither as the Alaska gold-bearing grounds became in process of exhaustion, and as careful combing of North America failed to find further gold-dredging ground which could be worked at a profit. The same interests have also invested to a considerable extent in the lode-tin industry in Bolivia, in which country the Patiño mines are by far the largest and best equipped.

Tin, therefore, in any form, especially in the ground, would seem to be a good buy—the only question being, as in other purchases, at what price. The price—$25 per share—at which the stock is being distributed appears to be currently warranted by the substantial dividends which are being paid: and there are established ore reserves—"positive" and "probable" ore—measured by one of our best firms of consulting mining engineers—which will last for several years, beyond which is the usual hazard of mining. The terms of the stock offer specifically pointed out that the profits which were being paid to stockholders were not, strictly speaking, dividends, but distributions of profits, since mines are wasting assets, and these distributions represent depletion of underground capital.

Stock issues are commonly held to be made for two purposes—for the raising of capital for purchase, extension, or improvement of property, and to pass on to the public ownership of shares for which the owner would prefer the cash at the price asked. In the present case the first motive does not appear. The stock obviously was the private property of Senor Patiño, held to be the richest man in South America, and who owns most of the stock of the company. The conclusion would seem to be that Senor Patiño would rather have $25 a share for this block of stock, minus the necessary commission, than the stock and the accompanying handsome dividends. That he does not need the money, at a sacrifice of future profit, seems certain from a consideration of his income from the stock which he still holds. It may be, therefore, that some conservative investors will decide that as to whether the stock is a buy at the price can only be determined by one who can best judge the hazards: and who has studied them better than Senor Patiño? It does not of course necessarily follow that he is right in preferring to turn seller: the acquisition some time ago of the Flat River mines by the St. Joseph Lead Co. by purchase from the American Smelting & Refining Co. was reported to have depended upon a difference in guesses by the respective parties as to the price of lead over a period of years; and it will take several years longer to decide the problem.

Chile's Bookkeeping

IF THE purpose of issuing periodic reports by companies whose shares have wide public distribution is to inform the public of the true status of such companies' business, the recently issued report of the Chile Copper Co. leaves something to be desired. In several important financial newspapers are to be found items of which the following from the *Journal of Commerce*, New York, is typical:

"Chile Copper Co. and Chile Exploration Co. report for nine months ended Sept. 30, 1926, surplus of $8,588,284 after depreciation, federal taxes and interest, equivalent to $1.95 a share (par $25) earned on 4,391,329 shares of stock. This compares with surplus of $8,878,882, or $2.02 a share, in first nine months of 1925. Surplus for third quarter of 1926 was $2,427,427, equal to 55c. a share, comparing with $3,023,413, or 69c. a share, in preceding quarter, and $3,276,235, or 74c. a share, in third quarter of previous year."

The impression created by this report cannot but be pessimistic; and yet an analysis of the facts, as revealed in the production figures and the reports for the first and second quarters of the year, shows clearly that the operations of the third quarter were more profitable than those of the second. The outstanding fact is that production of marketable copper in the third quarter exceeded sales by about 8,375,000 lb. By the accounting system employed, the value of unsold copper ready for market does not enter the financial statement, although the full cost of producing it is charged against operation.

In the accompanying table are set forth comparative figures for the last two quarters. The excess of production over sales in each period is assumed to be worth 12.5c. per pound and the values thus obtained are added to the corresponding net surpluses as shown in the reports. On this basis "earnings" per share are calculated for each quarter. Those of the second quarter are increased from 69c. to 72c. and those of the third from 55c. to 79c. A very different picture is thereby created.

The company makes public the figures of production and sale, and shows clearly that the financial summary is based on sales. Nevertheless, newspapers and the general public are prone to seize on the figures of dollars and cents, and to ignore those of tons and pounds. Chile officials might well draw particular attention to so important a feature of their report, when it is so easy for the public to gain an erroneous impression—an impression, in this instance, that is likely to have an unwarranted bad effect on the entire list of copper shares. The table follows:

	Production, Pounds	Sales, Pounds	Unsold, Pounds	Value of Excess at 12.5c.	Reported Surplus—Total	Reported Surplus—Per Share	Approximate Actual Earnings—Total	Approximate Actual Earnings—Per Share
Second quarter	54,164,000	53,059,000	1,105,000	$138,000	$3,023,000	69c.	$3,161,000	72c.
Third quarter	55,050,000	46,675,000	8,375,000	1,047,000	2,427,000	55c.	3,474,000	79c.

Scraping at the Park Utah Mine*

Method Now Used Reduces Hand Labor and Lowers Production Costs—Requires Careful Installation and Close Supervision—Can Be Modified to Work in Any Stope

By C. C. Cushwa
Superintendent Park Utah Mine, Keetley, Utah

MUCKING is the most laborious and costly operation in mining. Modern practice has lightened the labor and lowered the cost of most other mining operations. The windlass and the hand drill have disappeared almost completely from regions where power is available, but the hand shovel is only as effective today as it was fifty years ago, and is still generally used. Carbide lights have displaced candles and oil lamps. Hoisting has been revolutionized and pumping is an exact science. Many attempts have been made to avoid the trouble and reduce the cost of hand shoveling; some of these attempts are successful and others flat failures. Opposition to innovations has caused some attempts to fail and mechanical faults have been responsible for the downfall of others. The Park Utah mine has effected a material reduction in mucking costs by the installation of scraper hoists. As I am indebted to some operators for ideas about scrapers I desire to lighten that debt by giving a summary of the experience at the Park Utah mine to those who may be considering the use of scrapers.

The mode of application of scrapers varies with the timbering systems used in stopes. One method is used with square sets or stringer sets, another in wide orebodies which can be worked by cut and fill, and a third in narrow flat veins. Nearly all the oreshoots in the Park Utah mine lie at less than 50 deg. from the horizontal, and most of the ore is difficult to handle in flat chutes.

Care of Equipment Necessary

Proper care of equipment used is the first requisite for successful scraping, as serviceable equipment may be obtained from several manufacturers. At the installation of scraping equipment, a mechanic was placed in charge of all scraper and single-drum hoists. When the number of scrapers increased, he was given a helper and asked to care for all the equipment used in the work. This crew visits each hoist daily, oiling the engine and tail block, changing or splicing cables, making new "set-ups" when necessary, and by close inspection keeping the machines in good repair. The importance of this inspection and care cannot be overemphasized.

Park Utah uses ten Sullivan double-drum "Turbinair" hoists and one Sullivan double-drum electric hoist of the same general outside design and rated capacity as the air hoists. The electric hoist is slower and less flexible than the air hoists. It is, however, an effective machine in finely broken rock. The air hoists are fast and powerful, exceptionally well constructed and easy to manipulate, and have given entire satisfaction. Repair costs on the electric hoist have been nothing; on the air hoists they have amounted to less than two cents per ton of ore scraped.

*A paper under this caption was published in *Mining and Metallurgy*, for October, 1925. The present paper was prepared a year later and contains descriptions of modified equipment and the latest results obtained by this method of handling ore.

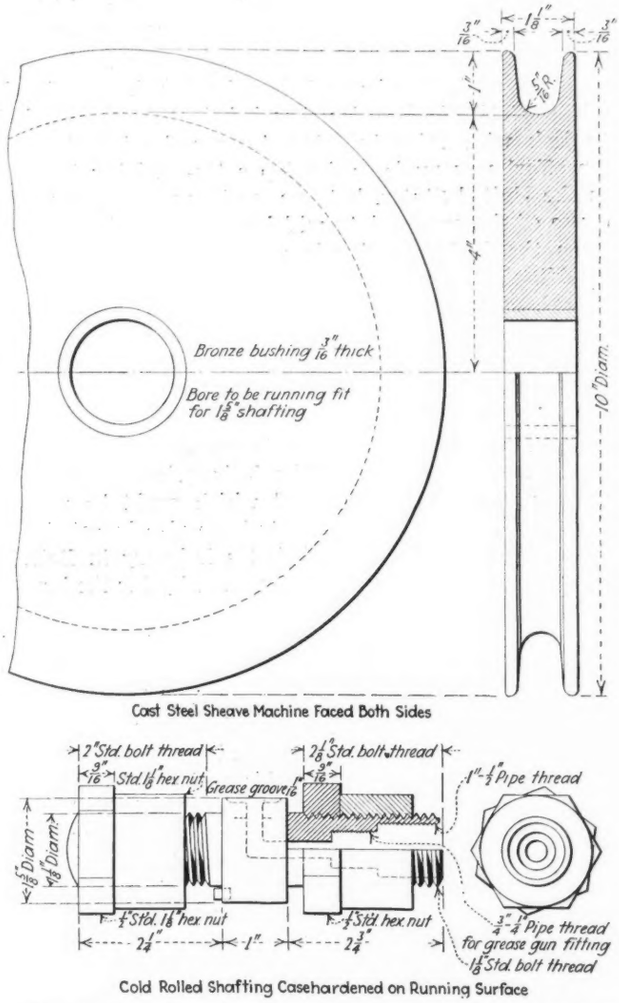

Bronze bushing 3/16" thick
Bore to be running fit for 1 7/8" shafting
10" Diam.
Cast Steel Sheave Machine Faced Both Sides
2" Std. bolt thread
2 1/8" Std. bolt thread
Std. 1 1/8" hex nut
Grease groove
1"-4 Pipe thread
Pipe thread for grease gun fitting
1 1/8" Std. bolt thread
Cold Rolled Shafting Casehardened on Running Surface

Fig. 1—Details of cast-steel sheaves with mountings

The hoist mounting now used, except in square-set or stringer-set stopes, is the turntable sold by the manufacturers of the hoist. A different mounting, which allowed the hoist to turn through only a 15-deg. arc, was used for some time. The new mounting allows the hoist to scrape in any direction, and is safer for the operator than the old one. In square-set and stringer-set stopes the hoist is bolted to a truck which may be run on a track or rolled over the floor; it is secured by jacks to the caps or girts.

Good Tail Block Essential

Next to the hoist the tail block is the most important appliance used in scraping. The management experimented with many types of blocks, and in the end was forced to design one to suit its needs. This block, illustrated by Figs. 1 and 2, has proved very satisfactory, and is relatively low in cost. It keeps the cable in the groove of the sheave wheel and withstands hard usage.

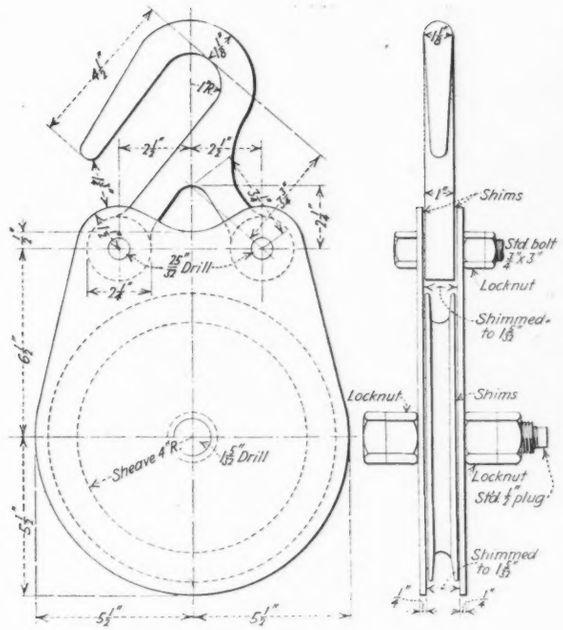


Fig. 2—Sheave block complete

It outlasts three blocks of any other type used, with much less wear on and no kinking of the cable. All other blocks, after short use, wore enough to permit the cable to enter between the sheave and the housing, thus kinking or breaking the cable. A great part of the operator's time had to be spent in attempts to free the cable, or to tie it as often as it was broken. This block looks heavy and cumbersome, but it has been found useless to work with light blocks.

Any good cable will give satisfactory results, but some are better than others. Experiments are being conducted to determine the best type of cable. It appears that a steel-cored cable is the best, for all hemp cores are squeezed out between strands in a short time. Abrasion on boulders or on the walls is the chief cause of failure, since the blocks described above were used. Unstranding is the worst effect, as a simple break may be spliced. Three-eighth-inch cable is used exclusively on scraper hoists. The greatest length used is 275 ft., as no attempt is made to scrape greater distances than 125 ft. The extra 25 ft. is used to allow for wear on the clevis end of the haulback rope.

After many changes in the design of scrapers, the hoe-type scraper shown in Fig. 3 was adopted as standard for hard-rock stopes. This scraper (also shown in the accompanying photograph) weighs about 350 lb. It has a heavy manganese-steel lip, which gives long life and great weight on the edge. The curve of the back of the scraper is right for digging; the weight of the lip keeps the scraper upright in fairly large boulders. This design assures one-man operation. A lighter

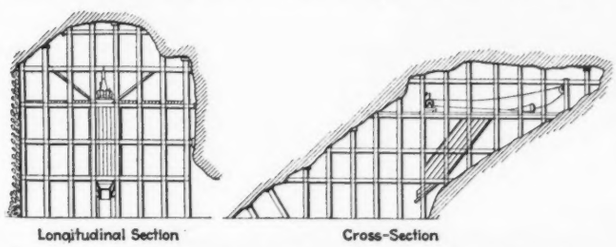


Fig. 4—Details of installation in flat square-set stopes

scraper of about the same design, using a plow-steel lip, is used in soft or fine rock. When boulders too heavy for the scraper are encountered, the scraper is disconnected and the boulders are pulled out of the way by tying the cable around them. They are then plugged and blasted at regular shooting times. Boulders weighing half a ton or more are usually blasted where they lie. In general, the larger the boulders, the heavier the scraper should be, up to the capacity of the hoist. This heavy scraper, when dragged over a soft bottom, will dig a deep trench which may dilute the ore with footwall waste.

The adaptation of scrapers to square-set stopes is illustrated in Fig. 4. Silling off is done by mucking, unless a convenient raise permits scraping. Inclined slides are sometimes used for sill work. The first floor may be scraped out, or handled through a "Mexican chute," and usually a combination of the two methods is used. Above the first floor all the rock is scraped. The hoist is mounted on a truck which runs on a track laid parallel with the walls of the stope, as near as possible to the hanging wall. The scraper is dragged in any line of sets from the footwall side toward the hanging wall. Chutes are "winged out" so as to receive ore from every line of sets where possible; in other

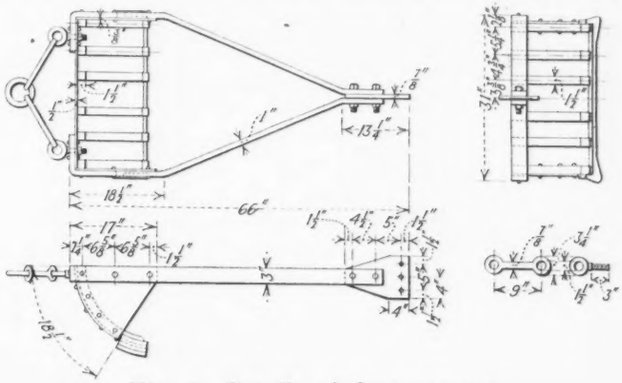


Fig. 3—Details of drag scraper

cases the broken ore is allowed to pile up until it is run into a scraping line which is served by a chute. In this case, when it is necessary to raise the scraping floor, the piled ore is dragged into a scraping line by using extra blocks, and then pulled into the chutes.

By leaving out interfering girts along the footwall several floors may be worked out from one position of the track. In one instance, in soft ore between good walls, ten floors were mined out without changing the scraping floor. This height depends on the distance the broken ore may fall without breaking the timbers. A line of 3-in. lagging nailed to the underside of caps above the track enables the operator to change his set-up in twenty minutes or less. The method used in Park City stringer-sets is identical with that used in square sets.

Fig. 5 illustrates the use of scrapers in wide orebodies with strong hanging walls. The sill timbering shown is novel, and has proved entirely successful. A line of 10 x 10-in. stulls was placed on the floor stringers so as to leave a drift-size opening along the hanging wall. This opening was laced off and the fill poured on the sill. The stulls held the weight of the gob until the stope from below was worked out, and the opening is still large enough for a car. This method may be used in only a few places; the usual plan is to use square

sets or stringer sets for sill timbers. Raises on the ends and in the center are kept open with square sets or stringer sets. When the sill cut is worked out, filling is poured in through the waste raises, and the scrapers are used to drag the waste toward the center.

Soon after starting operations it was found that the scraper works better on a floor sloping toward the hoist than on the level. It also saves mucking ore from under the hanging wall by sloping the floor downward from hanging wall to footwall. When a stope is mined as high as the walls will allow, the ends and haulageways are laced off, necessary bridging is done, and sill floors are laid. Waste is then poured in through the end raises, and the scraper is started, dragging the fill toward the ore chute. Unless waste is needed to brace the ore-chute timber, the fill is advanced as a breast. The scraper drags close to the footwall, and that part of the fill is easily finished. The filling under the hanging wall is done by using extra blocks to scrape in a diagonal line, and is finished by shoveling when the blasting floor is laid. When the fill has reached the required height at the ore chute, the laying of floor is started. Fine waste is used for leveling off, or the floor is laid on cross stringers if the fill rock is coarse. The flooring is 3-in. plank cut 8 ft. long. Each section overlaps the previously laid section by about 8 in. to prevent the loaded scraper from tearing out the planks.

Banking under the hanging wall, as mentioned above, is done as the floor sections advance from the ore chute.

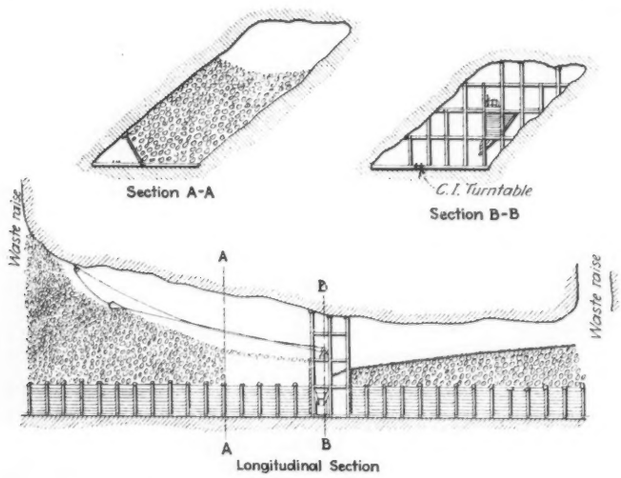
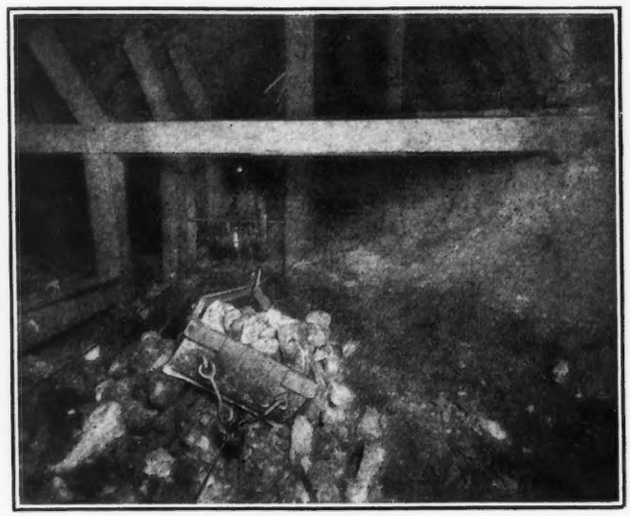


Fig. 5—Operation of scraper in flat open stopes

In very flat stopes or with sticky waste the fill is flushed with water. This results in a compact, loosely cemented filling which is particularly desirable on the sill floor. This wet waste causes trouble if the slope of the floor exceeds 10 deg.; then it is often necessary to place the floor on sprags and run wet waste up to the floor.

In narrow, flat veins the scrapers increase productiveness greatly. Silling off is done by drifting on the ore, and scraping can be started as soon as the hoist can safely be placed above the drift timbers. The stope is advanced like a rill stope, keeping the greatest height of back farthest from the hoist. Stulls are used to support the back, but one line of stulls is placed at about 5 ft. below the back of a cut, in line with the ore chute, so that slide lagging may be nailed to the stulls. This slide is used as a scraping floor and as a bulkhead to prevent the ore from falling into the fill. The height of



Scraper in operation at Park Utah mine, Keetley, Utah

the cut taken before changing the scraping floor depends on the condition of the walls and the slope of the vein; it is usually determined by the distance the broken ore will roll after being blasted. After advancing this distance the slide is placed and stoping resumed above the slide. Filling may then be started below the slide, if the slide is constructed well enough to prevent ore from falling into the gob. A double stope of this type is illustrated by Fig. 6. Pilot raises are not run for these stopes unless the vein is steep enough to carry waste filling. Ordinarily, these stopes are filled from hanging-wall waste raises.

Increased Production Records

A few of the best records made in scraper stopes wili serve to demonstrate how effectively the scrapers increase tonnage. One square-set stope four sets long by about seven sets wide produced 2,000 tons in one month, with four men on each of two shifts. One flat stull stope averaging 5 ft. wide by 100 ft. long produced 70 tons per day for two months, using four men per shift. One cut-and-fill stope produced 100 tons per day for six weeks, using three men per shift. The first two stopes were far enough away from motor chutes to require a trammer's full time, and the trammer was one of the four men in each case; the cut-and-fill stope scraped directly into a motor chute. This work was done by contract, under the best conditions obtaining in the mine; however, the scrapers have lowered costs and increased produotion everywhere that they have been used.

To all stopes not served by single-drum hoists, tools

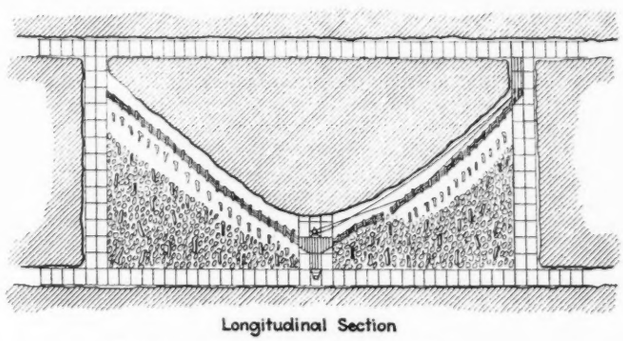


Fig. 6—Scraping in flat stull stopes

and material are elevated by the scraper hoists. Sublevel prospect work from stopes or raises is done cheaply by scraping the broken rock. Excavation inside and outside the mine can be done at low cost by using scrapers to remove the broken rock. Several thousand tons of dump ore was loaded, in the operations here described, into railroad cars, part of which ore was raised from the track level to the height of a gondola. This dump was loaded at a cost of about 40c. per ton.

Decreases Stoping Costs

The effect of scraping on mining costs is the best measure of its effectiveness. At the Park Utah stoping costs have been reduced 30 per cent, and more in certain cases, by the use of scrapers. Contract rates have fallen consistently. The contract rate in square-set stopes has not changed greatly, but it has been necessary to train square-set miners as well as scraper men. In cut-and-fill stopes the contract rate has dropped from 6c. per cubic foot to 4c., and good men can still earn an excellent bonus. In narrow flat stopes the initial price was 7½c., now reduced to 5c. Square-set rates vary from 7 to 8½c. per cubic foot, depending on length of tram and character of rock. The prices given are for labor only, but mean a material saving at the Park Utah mine, where mucking costs frequently amounted to 50 per cent of the labor expense in stoping before scrapers were installed. Now one man often cleans up a stope in half a shift, and timbers, trams, or runs a machine in the other half. This helps greatly to break in new miners, and it gives the young fellows a chance to learn all the moves in stoping. Speeding up the mucking has a good effect on all the men. The miners break more rock and the timber men follow with more timber. The net result has been lower costs and better satisfied men.

Diamonds Used in Diamond Drilling

Most of the black diamonds or "carbonados," usually called carbons, which are used in diamond drilling come from the State of Bahia, Brazil, though some are also found in Minas Geraes, according to the U. S. Bureau of Mines. They are found in gravel or conglomerate beds, which occur over a large area in these two states, and in beds of streams which have cut through the surface formations. Although found in Borneo, they have been mined only in Brazil.

Black diamonds range from stones of microscopic size to those weighing several hundred carats. The largest stone ever found was irregular in outline and about the size of a baseball. The average size of black diamonds, as found, is probably 5 to 10 carats. They are bought direct from the native miners by brokers or by representatives of the carbon houses. The black diamond is one of the rarest and most interesting of minerals; its chemical composition is exactly the same as that of the white stone, and its specific gravity ranges from 2.75 to 3.45. It is the hardest and toughest substance known. It is just as hard as the white diamond, which stands at the top of the scale of hardness, and is much less liable to fracture.

Black diamonds are generally believed to be composed of a large number of minute crystals firmly joined together and irregularly placed with relation to each other. They will take a rough but not a fine polish. The stones differ slightly in color; some have a reddish, some a grayish, and some a greenish cast, and other variations in color sometimes occur. The stones look like small cinders or pieces of coke; therefore they might be present in other parts of the globe without their commercial importance being known. The Brazilian black-diamond fields probably would not have been discovered if white diamonds had not been found there first. In some parts of the district white and black diamonds are found together, although the larger yield comes from places where white diamonds are rare.

Black diamonds in their natural forms seldom have the size and shape suitable for diamond-drill work, and therefore must be broken before they can be marketed. Breaking diamonds requires judgment and skill. The skill is shown by the way a workman breaks a large stone to get the greatest number of stones of the right size and shape. Approximately 20 to 25 per cent of the stone is lost in breaking.

The bort, which is often used as a substitute for the black diamond, is an imperfect gem stone or white diamond. It is fully as hard as the black diamond, but is a single crystal and fractures more readily. Borts may prove a good substitute for black diamonds in oil drilling where the formations are comparatively soft and the danger of breaking the stones is consequently much less than in hard formations. However, operators who have tried borts for coal prospecting have almost invariably found that black diamonds were more economical. It may be cheaper to use second-grade black diamonds for oil-field drilling than to use borts, which normally sell for about 60 to 80 per cent of the price of first-grade black diamonds.

An operator who is not thoroughly familiar with black diamonds will find it economical to employ a carbon expert to select the stones for his first bits. Diamond importers and manufacturers of diamond drills will usually select diamonds for their customers and make a charge of about $5 a carat for this service. Some brokers even guarantee to replace any stones that prove too soft or contain flaws, charging a slight increase in price to cover this guaranty.

The number of stones for a bit depends on the size of the bit. The small bits used in drilling for ores are ordinarily set with six stones, although as few as two stones have been used. Large bits used in Europe for drilling large holes contain forty to fifty stones. For ordinary oil-field work the bits will probably require six to sixteen stones.

The stones used in metal prospecting ordinarily weigh 3 to 4 carats each. They have ample cutting surfaces and enough body to let them be firmly fastened in the metal of the bit. Stones of this size should not project more than one thirty-second inch beyond the outside of the metal. When mud fluid is used with the diamond drill, larger stones which will project further out from the face of the bit will probably be needed. In this event the stones that will be used in oil-field work may weigh 7 to 10 carats.

Information in regard to the operation of diamond drills, with special reference to oil-field prospecting and development, is contained in Bulletin 243, by Frank A. Edson, copies of which may be obtained from the Bureau of Mines, Department of Commerce, Washington, D. C.

Upper Mississippi Lead-Zinc Field

By E. G. Longhenry

IN PREPARING this brief historical statement on the Upper Mississippi Valley lead and zinc fields, I wish to explain that I have drawn freely on Bulletin No. 26 of the Illinois State Geological Survey.

The field lies mainly in southwestern Wisconsin, but includes part of northwestern Illinois and a part of northeastern Iowa—covering about 4,000 square miles, in the "unglaciated oasis" left untouched by the great glacier of the last ice age. The surrounding country was all planed down to a common level, but this region is a land of scenic beauty, is rugged and picturesque, and some bluffs on the Mississippi stand 600 ft. high.

Archaeologists claim that this is the best and most interesting place in the country to study the early mound builders. The Indians called it Manitoumie—Land Where the Great Spirit Loves to Dwell. So beautiful and attractive is this region, extending beyond the field south to Rock Island, and north beyond the field to Wabasha, a total distance of 300 miles, that Congress has authorized an expenditure of $1,500,000 for the purchase of lands along the Mississippi. Various organizations are now working for the establishment here of a National Park.

Julien Dubuque was the first white man to settle in the mining region and seriously attempt mining. This was in 1788, and under Spanish rule. The east side of the Mississippi River was under French rule, but at the close of the French and Indian war the Galena region became English territory in 1763. After the Revolutionary War the title passed into the hands of the United States. English influence in the lead region then waned, but she hated to let go; for in 1805 Lieutenant Z. Pike, U.S.A., shot down the British union jack from the post at Leech Lake and ran up the Stars and Stripes. During the War of 1812 the Indians produced a large amount of lead for bullets under the direction of English officers. And the British flag floated over Prairie du Chien until 1815.

Some of the first miners of the region secured protection from the Indians by marrying Indian wives. Real active mining on a large scale was begun at Galena in 1823 by Colonel Johnson, who had besides miners 150 slaves under military protection. From then on hordes of prospectors and squatters swarmed into the district. By 1830 the number reached 30,000 people. St. Louis then had less than 7,000; Chicago had twelve houses. Milwaukee and St. Paul were not on the map. At this time Black Hawk stirred up trouble among the 3,000 recalcitrant Indians (from whom Uncle Sam had bought 8,000,000 acres of land for $60,000, which was resold to settlers for $2.50 per acre), resulting in the Black Hawk war.

The lead mines of this region were among the first within the United States to produce large quantities of lead ore, and for many years they afforded the chief supply of lead produced in this country. The greatest activity was between 1840 and 1850. In 1845 and again in 1847 more than 27,000 tons of lead ore was produced from this region—an amount equal to 10 per cent of the world's production and 87 per cent of the American output for those years. Much of the lead exported went to China. This showed that these mines were of international as well as national importance. The estimated lead-ore production up to the year 1905 was over 600,000 tons. An equal amount was lost by crude treating and smelting methods, it is estimated. Early in 1861 Robert H. Champion, of New Diggings, struck one of the largest lodes of lead ore of the early days of shallow mining. It produced 17,000,000 lb. of lead ore, which is said to have netted the owners more than $1,000,000.

The Paragon mine, opened up in 1840 at Vinegar Hill, produced 27,000,000 lb. of lead ore, all taken out above the water level. The Marsden lode, found in 1854 by Stephen Marsden, while cleaning out a spring, four miles south of Galena, produced about 8,000,000 lb. of lead ore. Since then it has been a heavy zinc-ore producer, producing a car or better per day, besides one to three cars of lead ore per month. The Rountree range, at Platteville, was another immense lode that was worked by the "open-cut" method. The miners rolled the big chunks of pure lead ore on to skids and "snaked" them out with ox teams.

In these early days of lead mining the zinc ore was considered not only of no value but as a positive nuisance by the miners. The first attempt to utilize it was made, after some preliminary experiments, in 1858, and zinc-smelting works were erected at La Salle, Ill. The following year the manufacture of zinc oxide was begun at Mineral Point, Wis. Since then there has been steady shipments of zinc ores from the field.

At first the carbonate ores (dry bone) only were used, but eventually means were found for the economical roasting of the sulphide ores, and a demand for them created. The first "jack" (zinc sulphide) shipped out of the field was from the old Rooney-Swift mine, near Benton. The ore buyer told them he would allow $3 per ton. This was in 1863, and as neither party would advance the freight charges the railroad men threw it out. A few years later the smelterman loaded it, paid the freight, and made the settlement of $3 per ton with the mine owners. "Jack" was shipped regularly thereafter.

In 1899 Prof. Elwood G. Perisho, once State Geologist of South Dakota, suggested that "jack" be searched for underneath some of the lead ranges, as the geological conditions were ideal. This resulted in the discovery of the Enterprise mine. In the fall of 1901 the Empire Mining Co. was organized, but the mine was not found until 1903. These two mines are on the same lode and produced and sold more than $1,000,000 worth of ore, up to the time they were taken over by the Wisconsin Zinc Co. Since then the field has produced many large and rich zinc deposits, many of them on leases that had been tried out before by drilling, in some cases by five or six different companies.

Several new mines are operating with local capital and some outside capital is being invested in the field, but the increased production and development are mainly due to the extension of operations by the old and larger companies, the Mineral Point Zinc Co. and the Vinegar Hill Zinc Co., each having a chain of mines and a number of drills on exploration work.

Recent developments show that many times as much profit is being won from the deeper workings as from the early shallow lead diggings. The favorable situation of the district with regards to transportation facilities, smelters, fuel supplies, power lines, and the excellent hard roads almost everywhere may be expected to aid materially in further development.

Hexagonal Grinding Rods Tested in Patiño Mill

By E. H. Rose,
Mill Superintendent, Patiño Mines & Enterprises Consolidated, Inc., Llallagua, Bolivia

ARE hexagonal rods more effective for grinding in a rod mill than are round rods? Experiments which this article purposes to describe and which have just been completed indicate that hexagonal rods are indeed superior, so long as they retain their flat faces—but that they soon lose their advantage for the good reason that in service they immediately become round.

Largely as the outgrowth of the movement to replace spherical balls by cubes as grinding media, there has been frequent mention recently of the possible use of square, hexagonal, or octagonal rods in grinding mills. The reasoning appears to have been that if a cube is superior to a ball, then a polygonal rod should be superior to a cylindrical rod. So far as I am aware at the time of writing, this idea has not heretofore been taken beyond the speculative stage. At least, I have seen no description of any trial of flat-faced grinding rods, in spite of frequent conjectural reference to their probable superiority.

The matter has recently been subjected to experimental study at the Victoria Mill of the Patiño Mines & Enterprises Consolidated, at Llallagua, Bolivia. A special lot of hexagonal grinding rods was secured from the United States, for the specific purpose. These were non-alloy, carbon (1.0 per cent) steel rolled rods, 10 ft. long and 3 in. in diameter between flat faces. Each rod weighed 115 kilos when new, compared with 108 kilos for new cylindrical rods of the same length and diameter. A charge of 9,860 kilos of the hexagonal rods, all of them new and of equal size, began service in a 5 x 10-ft. rod mill on June 5, 1926. The rod load was thereafter increased and maintained at 10,500 kilos, by the occasional addition of similar new, hexagonal rods. The interior of the mill was not again examined until Aug. 17, 1926, seventy-three days later; at that time it was found that all of the original rods had become perfect cylinders, whereas those which had been added later were in various stages of gradation from hexagonal to circular cross-section. The course of their wearing down is shown in Fig. 1, which is a composite drawing of the ends of five rods of different "age" in the test. It is seen that the original hexagons became true circles by the time that they had reached a diameter of slightly over 2¼ in. At this diameter of 2¼ in., the rods showed no appreciable taper toward either end, although somewhat later they did develop a taper as follows: feed end, 1 15/16 in. diameter; center, 1 11/16 in. diameter; discharge end, 1¾ in. diameter.

Operating conditions were as follows:

The mill was a 5 x 10-ft. Allis-Chalmers, two trunnion type with drum feeder, the trunnion discharge having an opening 16 in. in diameter. For temporary reasons not concerned with the test, the discharge opening was decreased to 12 in. by annular wooden lagging. Liners were new at the beginning of the test, and were standard Allis-Chalmers "ship-lap" type. The mill made 20 r.p.m.

The feed was a mixture averaging 40 per cent cassiterite, 45 per cent pyrite, and 15 per cent quartz gangue. Cassiterite is naturally a hard mineral, and in a mill is found to be almost carborudum-like in its abrasiveness. Pyrite of course tends to set up an acidic condition; in addition to this, acidic mine water was used in the circuit, so that the rods were subjected to rather severe corrosion as well as abrasion. No lime was used.

The feed rate was 110 dry metric tons per twenty-four hours, averaging 70 per cent solids. Following are screen analyses of rod-mill feed and discharge. The samples for these were taken after the rods had been in use for one week:

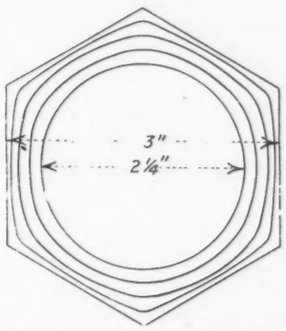


Fig. 1—Diagram showing relative shapes of hexagonal grinding rods

Mesh	Mill Feed: Per Cent Weight Retained This Mesh	Mill Feed: Per Cent Weight Retained Cumulative	Mill Discharge: Per Cent Weight Retained This Mesh	Mill Discharge: Per Cent Weight Retained Cumulative
+ 10	22.6	22.6	....	....
+ 20	17.4	40.0	....	....
+ 40	18.8	58.8	0.5	0.5
+ 70	10.4	69.2	5.5	6.0
+100	6.4	75.6	11.0	17.0
+150	2.8	78.4	11.0	28.0
+200	10.6	89.0	25.0	53.0
—200	11.0	100.0	47.0	100.0

The mill was in partly closed circuit with a 2-ft. 3-in. x 15-ft. 4-in Dorr simplex drag classifier. Screen analyses given are of original feed to, and final product from, the grinding circuit. The object of the grinding operation was the preparation of mill gravity concentrate for the subsequent removal by flotation of its pyrite content, to leave a clean cassiterite shipping product.

Inasmuch as the rods became round so rapidly, determination of the grinding effectiveness of flat-faced rods immediately ceased to have any point, although of course when the test was begun it was not known with complete certainty that the rods would not retain their shape, and consequently the essential data were taken for comparison with originally round rods. Further contemplated tests, with round rods under conditions as nearly the same as it was possible to make them, were therefore not conducted. It is worthy of note, nevertheless, that a comparison between the average of several screen analyses, taken when the rods were still hexagonal, with the average of several similar screen analyses taken when all but a few recently added rods had become round, showed approximately 4 per cent more minus-200-mesh material in the round-rod product and at the same time 9 per cent more retained on the two coarsest sizes, with a production of less of the desirable plus 100-, 150-, and 200-mesh material. In other words, the round rods left a wider spread between coarsest and finest product, giving more undesirably

coarse material in the mill discharge and at the same time producing more detrimental slime. The metallurgical effect in this particular case was to dilute the final concentrate with pyrite too coarse to float and at the same time to increase the tailing loss by producing slimed cassiterite, which was then carried over mechanically in the flotation cells and lost with the pyrite froth.

The production of minus-200-mesh material in this

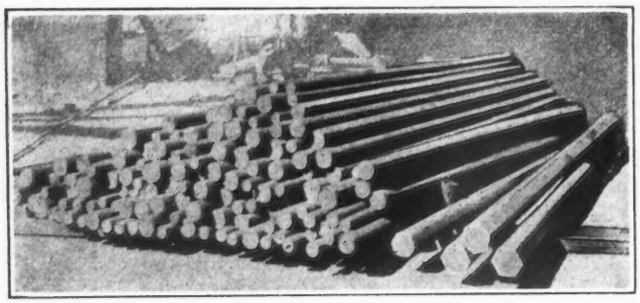


Fig. 2—Charge of hexagonal rods after removal from mill. Three new, unused rods at right for comparison. (These have their edges chalked, to photograph well.) Next to the three new rods is one rod which had been in service four days

case is not necessarily, however, a criterion of the grinding effectiveness of hexagonal rods under more ordinary conditions, for the specific gravity of the cassiterite (making up nearly half the mill feed) is so high that sliming of part of it is favored because of classification within the mill.

Power input also ceased to be of great significance for the purpose of the test, because the rods wore round too soon to give any dependable average figure for hexagonal rods in a rod load of known weight.

The entire charge of rods was removed from the mill on Sept. 16, after slightly over three months' service. Fig. 2 is a photograph taken at that time, showing all of the rods figuring in the test. All of these had originally been hexagonal. (Note three new rods at right of picture for comparison.)

The present brief article is written as a sequel to my discussion of grinding cubes which appeared in the July 17, 1926, issue of this journal. The two discussions are related by the question, "Why do cubes retain their flat faces—as they invariably do—whereas hexagonal rods do not?" The answer is not difficult to discover:

As pointed out in the previous article above mentioned, cubes are *not* subjected to the haphazard tumbling in a mill which for a long time was assumed to be inevitable. On the contrary, they maintain rectilinear alignment with respect to the axis of the mill, just as rods do. As the predominating case, one axis of the cube must be parallel with the axis of the mill if the cube is not to undergo corner wear that would modify its shape. This obviously means that, in a mill in action, the majority of the individual cubes in the mill have one axis parallel with the mill axis at any one time, and so, in a manner of speaking, they are aligned approximately in rows along the length of the mill—very imperfect rows to be sure, but still with a resemblance to a square rod cut up into cubes. Taking this point to its logical conclusion, it is seen that cubes would be worn to cylinders, just as hexagonal rods are, *if* it were always the same axis of an individual cube which is parallel with the axis of mill rotation. In such a case, there would always be rotational edge wear upon the same four edges of a given cube, and a short cylinder would result. The two ends of this short cylinder would be forced to remain flat by virtue of the attritional wear of the two adjacent cubes of the imaginary sectionalized rod of which the given cube is one member. To reverse the simile, one might imagine cubes strung upon a slender rod, after the fashion of beads upon a thread; the cubes in such a string would be worn to cylinders, in a mill, as hexagonal rods are.

But cubes do not have to be so strung together in order to be able to maintain rectilinear orientation in a mill; their retention of shape is alone proof enough that they do so without artificial aid. Even though they do maintain such orientation, any one pair of their three pairs of opposite faces may be that which is parallel with the ends of the mill, while the remaining two pairs are taking the rotational abrasion; any one of the three pairs of faces may be that constituting the ends of the short rod, and the pair subject to the action which keeps them flat. It is to be remembered that the "short rod" is not itself necessarily revolving, but is only being carried around in a revolving mill. Thus there is opportunity for plane attrition even upon the four faces taking the rotational wear. Certainly the rounding action, even though affecting four faces, is not sufficient to overcome the flattening action taking place at the same time on not necessarily more than two faces. With cubes, "bucking-board action" must predominate; otherwise distortion of shape would be inevitable.

In the light of this, let us return to polygonal rods. Assuming for the moment the not entirely tenable belief that rods in any rod mill give line contacts among themselves, there can scarcely be a doubt that flat-faced rods would under those conditions be the nearest practicable approach to the ideal grinding medium. The fact that flat-faced rods have so often been suggested as a further improvement over cubes implies general acceptance of that statement. Unfortunately for polygonal rods, it cannot be demonstrated that any rods do give line contacts under ordinary operating conditions (although the wearing round of hexagonal rods is by no means proof that they do not give line-surface contacts); if rods could be made to remain perfectly parallel in a mill, and so give true line or parallel-surface contacts, it would be an easy matter to establish the superiority of polygonal rods over cylindrical rods. But even under those ideal conditions there would still remain the problem of preventing the polygonal rods from immediately losing their original shape.

Unfortunately, the mill trial herein described indicates that under ordinary conditions hexagonal rods cannot be forced to retain their flat faces, and that for the same reasons square rods probably could not either, especially if their edges were beveled. The only apparent method of keeping a square rod square is to cut it up into equidimensional bodies—cubes—so that the axes of "rotation" may be freely interchanged through ninety degrees. What happens when a hexagonal rod is cut up into sections with length equal to inter-face diameter? The body then wears to the form of a cube, as trial will prove.

It does not appear that alteration of the shape of the mill would force retention of flat faces on rods, so long as the mill rotates, for it is that rotation and not the shape of the mill which causes the rounding effect. This applies as well to "balanced-compartment" rod mills.

Curious Methods Used by Katanga Natives in Mining and Smelting Copper

Workings Probably Started by Arab Slave Traders; Not Ancient as Sometimes Said—Ceremonies and Sorcery—Wire Drawing Accomplished by Bayeke Tribe

By T. A. Rickard

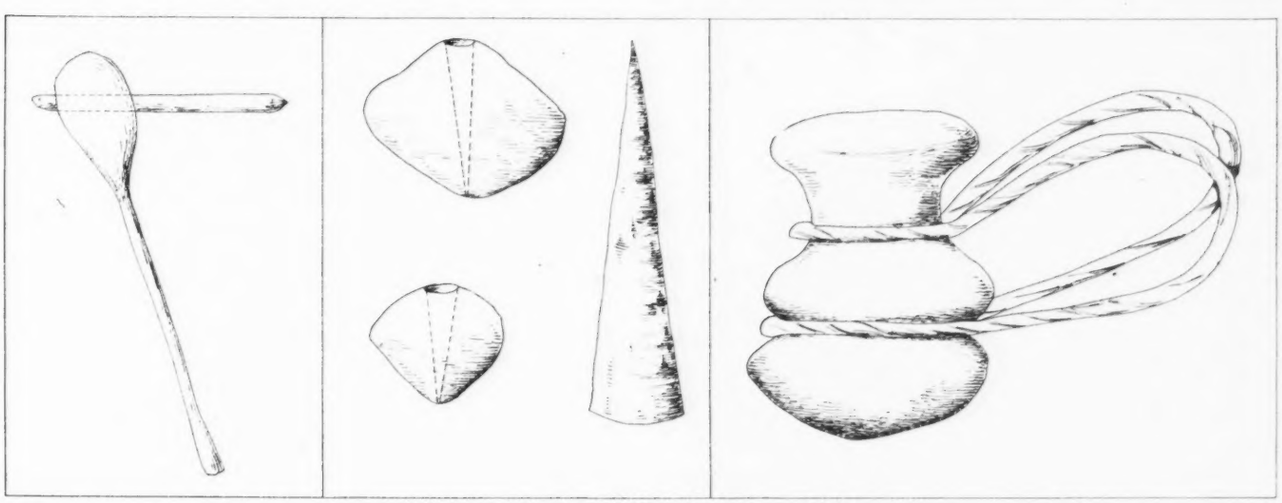
THE MINING AND SMELTING of copper ore in the Katanga province of the Belgian Congo presents many phases of peculiar interest, partly by reason of the light it throws on the probable methods used by primitive man as much as five thousand years ago, when copper was obtained, for example, by the Phoenicians in Cyprus and by the Egyptians in the Sinai Peninsula. Evidence of old workings has been found in many parts of the Katanga; indeed, no deposit of copper ore discovered by the engineers of the Union Minière has lacked the signs of having been exploited in former days. These abandoned workings, now covered with grass, have been called "ancient," but such an epithet is not warranted by the information available.

The appearance of the workings, and their general character, resembles that of the diggings in which the present indigenous population, of negroid race, was seen at work only a few years ago, when the representatives of the Union Minière commenced the exploration of this highly mineralized region. It seems probable that the old diggings were started under the direction of the Arabs when they controlled the slave trade in Central Africa. The slave traders, we may suppose, compelled the natives to dig the ore, where it appeared at the surface, and to smelt it afterward in small furnaces of crude construction. They treated only small quantities of picked ore, usually the nearly pure carbonate, malachite and azurite, which, when necessary, they concentrated by washing in baskets. When the British stopped the slave trade, the natives continued to mine and smelt the copper on a small scale, having found that they could exchange it for the commodities they desired, including wives. The so-called ancient workings therefore are unlikely to be more than a hundred or a hundred and fifty years old.

Livingstone Recorded African Copper Mining in 1871

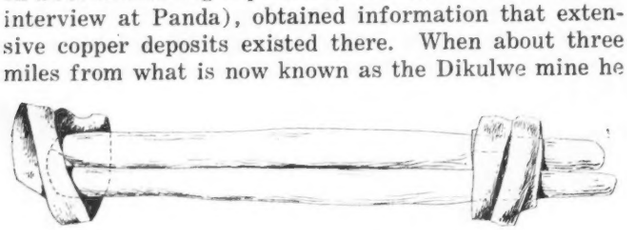
Since writing the above I have found a most significant, and confirmatory, statement in "Livingstone's Last Journals," page 373: He wrote in 1871 as follows: "Hassani, with ten slaves, dug at the malachite mines of Katanga for three weeks, and gained a hundred *frasilahs* of copper, or three thousand five hundred pounds." Hassani was an Arab trader from Zanzibar. While at Casembe, in Lat. 9 deg. 37 min. S. and Long. 28 deg. E., Livingstone wrote, on page 214 of the same book: "About a month to the west of this the people of Katanga smelt copper ore (malachite) into large bars shaped like the capital letter I. They may be met with from fifty to a hundred pounds' weight all over the country, and the inhabitants draw the copper into wire for armlets and leglets. Gold is also found at Katanga, and specimens were lately sent to the Sultan of Zanzibar." Here I may quote another of Livingstone's notes on the same subject (*Op. cit.*, page 290): "The malachite of Katanga is loosened by fire, then dug out of four hills; four *manehs* of the ore yield one *maneh* of copper; but those who cultivate the soil get more wealth than those who mine the copper." He wrote this when at Ujiji in 1871.

In 1920 T. S. Carnahan, accompanied by a native interpreter, went to Musonoi, 150 miles west of Panda, now one of the chief centers of mining activity in the Katanga. Mr. Carnahan went to this western district



Left, a mining pick used by Katanga natives. Center (at left), draw plates, one-third natural size, for making wire. The conical implement at the right is a hammer, one-sixth natural size. Right, forging hammer, one-third natural size

on a reconnoitering expedition, having, he told me (in an interview at Panda), obtained information that extensive copper deposits existed there. When about three miles from what is now known as the Dikulwe mine he



Sorting hammer, one-third natural size

could see, by aid of a field glass, a long low ridge on which a large number of natives were at work. He approached quickly in the hope of seeing what they were doing before they should stop their work, but when he was still a mile away the hill was deserted by the natives. When he arrived on the ground he found no one there. He was inspecting the outcrop and the shallow diggings when an old gray-bearded native, not more than 5½ ft. in height, emerged from the bush. This old man saluted Mr. Carnahan in European fashion and talked with him, through the native that he had brought with him as an interpreter. It was made clear that the old chief was suspicious of the designs of the white man; whereupon he was assured that no harm was intended and that the working of the mine would suffer no interference.

Mr. Carnahan asked him to persuade his people to return to their work, and, after some slight hesitation, the old man gave a signal, the character of which Mr. Carnahan could not detect, summoning the natives to work. From a distance of as much as half a mile the natives came streaming back in single files out of the bush, and resumed work forthwith. Most of the miners were women, to the number of about two hundred, working under men, in the ratio of one *capita,* or boss, to fifteen women. Many of these were naked save for a scanty loin-cloth. They were of much better physique than the natives of the Katanga, and appeared to have been brought from the Angola country. They wove their hair in fantastic forms plastered with clay.

Natives Mined Soft Ore in Dolomite

The diggings consisted of irregular holes in a siliceous dolomite; the natives were mining only the soft ore in small veins and seams in this dolomite. The product was nearly pure malachite in small pieces, none so large as a fist. The workings were in the form of inclined openings, following the rich ore, so that no ladders were needed. Ten women went into one of these holes; the one at the bottom filled a basket, containing 25 lb. of ore, which was then passed from hand to hand as they squatted on the ground, until it reached the surface. The inclines were from 30 to 40 ft. deep. No lights were in use.

On the surface the *capita* emptied the basket on the ground, and other women began at once to sort the ore, throwing aside the sterile pieces, while the selected mineral was put into another basket, which one of the women carried to the stream at the foot of the hill, a distance of about two hundred feet. Six women stood in the water up to their knees and washed the ore in baskets to which a circular movement was given as in the ordinary panning operation of the prospector. The resulting concentrate was emptied on the bank, to be carried later to the village, three miles distant, where it was smelted, and made into cruciform ingots of seven inches, weighing about half a pound.

When Mr. Carnahan was about to depart he found himself attended by two little old men with long gray beards, armed with Spanish muzzle-loaders, which were considerably longer than their owners. These antiquated guns were ornamented with brass, and were the sort of weapon that the Arabs brought from Zanzibar. The two military veterans escorted Mr. Carnahan for two miles; then they saluted silently and immediately disappeared in the bush. The old chief who was the first person seen said that the mine had belonged to his family for several generations. Subsequently, in arranging to work the mine, the officials of the Union Minière were asked to give 30 kilograms of copper annually by way of compensation, and later, when the natives had been advised, by some whites presumably, that they could get more, they increased their demand to 200 kilograms, which, of course, was but a slight rental for a mine of such promise.

While at Elisabethville, the center of administration of the Union Minière du Haut-Katanga, the company operating the mines in the southern province of the Belgian Congo, I had the good fortune to meet a missionary bishop, Monseigneur J. De Hemptinne, who had collected data on the subject of indigenous metallurgy, and from him I obtained a type-written description[1] of which I shall avail myself freely herewith.

Native Metallurgists Dying Out

The surviving native metallurgists are old men; their art, like themselves, is passing. It appears from what they say that three former centers of activity are recognizable: in the east as far as the Lufira; in the center, between the Lufira and the Lualaba rivers; and in the west, on the left bank of the Lualaba, or Upper Congo. In the east the indigenous production of copper ceased long ago; in the center, it was decaying when the Belgians arrived; in the west, it was still active when the region was first opened to modern industry.

The old mines of the eastern district consist of holes 90 to 125 ft. wide and from 20 to 25 ft. deep. Such have been found at Lukuni, Luishia, Kapushi, and Luano. The appearance of these diggings indicates that they were abandoned long ago; this is indicated by the erosion and by the growth of slow-growing hard-wood trees of considerable size. The oldest natives have no recollection of mining operations in these localities. The last metallurgist of their race, they say, was Kipai, the brother of the great chief Katanga, who received the invader, Muyeke Kalaba, the leader of the Bayeke tribe, and made friends with him. That takes us back to about 1850. The tradition of the copper mining appears to have died about the time when the surviving old men were born; they know nothing about the technique of their ancestral art; they recall only the fact that the copper was drawn into long thin bars from which were made the bracelets that some of the old women still wear.

First Trading Probably with Arabs

Why did the natives cease to produce copper even before the Europeans arrived? Apparently this was due to the slight use they made of copper and the lack

[1] A paper entitled "Les Mangeurs de Cuivre du Katanga."

of a market for exportation. The first outlet for their copper was that afforded by the Arabs. The exploitation of copper in both the eastern and central districts was started and maintained by barter with the Arab traders on Lake Tanganyika, these in turn being in touch with the Arabs of Zanzibar. Although it is not possible to state when this trade began, we know that it lasted until the middle of the last century, according to the testimony of the old chiefs. The invasion of the Bayeke appears to have coincided with the last days of the Arab trade, for the invaders killed commerce by rendering communication insecure. The conquest of the country by the Bayeke, however, created a new market for the copper for a while. The Bayeke found an outlet westward through the Balema tribe and the natives of Angola, now Portuguese territory extending eastward from the Atlantic coast. Some of the old men in the Katanga remember serving as porters in expeditions that carried the copper as far as the western ocean. This copper was exchanged for guns and powder; but this trade never approached in its importance the earlier traffic with the Arabs. The Bayeke metallurgists were few in number and they held tightly to the monopoly of the market they had found, so that all the mines of the western district, abandoned by their former workers, remained idle.

The mining activities associated with the invasion of the Bayeke were localized almost entirely in the central district, between the Lufira and the Lualaba, both tributaries of the Congo. Some of the metallurgists of the Basanga tribe, the aboriginal people, worked with the Bayeke metallurgists, but most of the Basanga abandoned the mines, and their special ways of smelting ceased to be practised. The Bayeke made copper wire, whereas the natives of the west cast their copper in the shape of St. Andrew crosses, which served as a medium of exchange in their trade with the Kasai and the Lomami in the basin of the Lower Congo. The introduction of European coins has decreased the demand for this cruciform copper money, but even today it is used in barter among the natives of the west.

Native Guilds Guarded Secret Methods

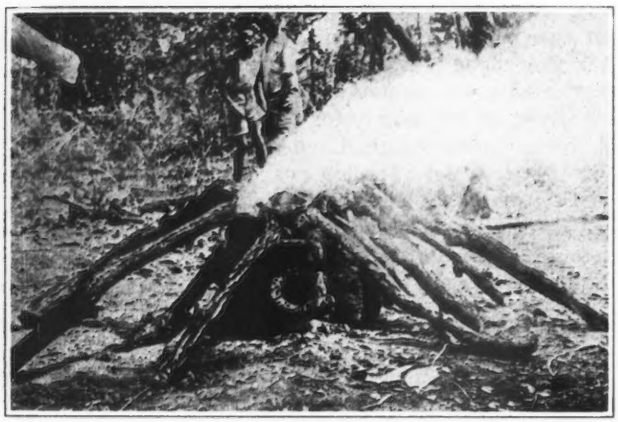
The metallurgists of the central district belong chiefly, as we have seen, to the Basanga tribe. Other tribes specialized in other industries; for example, the Balebi in pottery, the Mobambi in iron smelting. There appears to have been a division of labor among the natives and the rudiments of an organization according to crafts. These guilds or corporations had their professional secrets, which they joined to the technique of their operations. The mines of the Basanga were the sites of the important operations of today, such as Kambove, Musesa, Kituru, Lukasi, and Kamatanda. Their smelting plant consisted of two furnaces, one for reduction and the other for refining. The smelting was done in a furnace 5 ft. high and 3 ft. in diameter. It was constructed of clay obtained from the ant hills. The furnace was supplied with air from four bellows. This equipment was sheltered by a grass roof. The casting furnace was about three feet high and of similar construction. It was actuated also by four bellows. The hearth of the furnace consisted of a hole lined with wood ashes. In front of the tap hole was a mass of clay well mixed with ashes in which the cruciform mold was made.

The Basanga made a cross as much as 3 ft. long and 2½ in. thick; the weight of it is said to have been such that two men were needed to carry it, tied to a pole. They also made a smaller size, such as one man could carry, and a yet smaller one, of which one man could carry two, so we may infer that those three kinds of cruciform ingots weighed something like 100, 50, and 25 lb. respectively. The big one, says an old chief, was the price of a wife; and if the woman had exceptional qualities the bargain called for the addition of a small cross. The price of a man was slightly less. At that time guns were not on the market.

Incantations Employed to Assist Recoveries

The Bayeke came from the eastern shore of Lake Tanganyika; they heard of the riches of the Katanga, in copper and ivory, through the Arabs; and when the Bayeke, incited by such information, invaded the eastern part of the Katanga, the Basanga, who lived there, lost their outlet for copper toward Tanganyika. It is true they found a market among the newcomers, but it was a poor one, because these invaders began to produce the metal on their own account. The Bayeke, it is said, had smelted iron in their own country and so they soon learned how to produce the copper. They adopted the traditional rites of the Basanga at first, but when they acquired the art themselves they formed their own associations and formulated their own incantations, which constituted a necessary part of the metallurgic performance. The methods developed by the Bayeke differed from those they found in use by the Basanga in that they used temporary furnaces. Both the blast furnace and the casting furnace were destroyed by them after each operation. De Hemptinne saw the natives smelting copper ore at Katanga in 1911; and at Dikulwe in 1924 he persuaded them to give a demonstration of their methods. This was done in the presence of Mr. Leon Rasson, the general manager of the Union Minière, and several engineers of his staff. Monseigneur De Hemptinne gives a detailed description of the performance, and I venture to translate it freely into English, together with some of my own comment, as follows:

The chief of the village issued the summons: "Come, let us bring forth the copper!" Forthwith the natives began their preparations for the metallurgic campaign; the women prepared food, pounding the corn with their pestles and filling their baskets of plaited bamboo with the white flour; the men seized the tools that had remained, idle and dusty, in their smoky huts since the last campaign. The bellows had to be mended, for the antelope skin of which they were made had suffered from the depredations of ants, cockroaches, and rats. The hatchets needed sharpening and tempering, for use in cutting the hard wood that served as fuel. The picks and trays required for extracting the ore had to be collected. The native's pick is much like his hatchet, or, perhaps, having regard to the shape of our axes, it might be better to say that his hatchet is a good deal like his pick. A wooden handle terminates in an enlargement, like the head of a club, and in this the iron is inserted by a perforation. The cutting edge of the pick, instead of being in the line of the haft, is placed transversely like that of a hoe. The haft and iron of the pick are much heavier than those of the hatchet. The tray, or pannier, is made of fibrous bark, and is of cylindrical shape. It is 16 in. deep and 10 in. in diameter, so that it has a capacity of about 50 lb. of ore.



A smelting furnace in operation. The branches serve as props for the seemingly shaky structure

The performance begins: The chief, surrounded by the grand sorcerer and the founders, or metallurgists, invokes the spirits of the mine. These spirits are those of bygone leaders of the tribe. The chief appeals to the spirits: "You have preceded us; it is you who have opened the inside of the mountain for your children; grant us the favor of finding treasure there." Thereupon, the men, women, and children take the path to the mine on the hill. Arriving there, they set to work building conical huts, made of branches and thatched with grass; these are for the chiefs and other notable persons; the common folk are lodged in a circular inclosure, open to the sky. A hedge of intertwined trees serves to exclude wild animals from the camp, which is not situated at the mine itself, but on the bank of the nearest stream.

A spot is found where the malachite appears at surface; digging is started. If the rock is too hard for the pick, the natives fill the hole with wood and set it afire. This method, known as "fire-setting," was common among the early peoples of Europe and was in use in the mines of Norway so lately as 1876. The heat, followed by contraction on cooling, cracks the rock. Usually the natives do not mine deeper than 40 to 50 ft.; and their passages underground are not longer than 60 ft. For making ladders they use the lion's hide. For artificial light, when needed, they burn a clump of straw. Three men work at the bottom, and fill the panniers with small lumps of malachite or of rock, separately; on the ladder both men and women, perched alternately, pass these products from hand to hand toward the surface. There the pieces of ore are sorted by women and children, the selected material being thrown into a tray, in which it is carried to the place of smelting, and there heaped in a pile ready for reduction.

Charcoal Made From Hard Wood Used in Smelting

The fuel likewise is prepared; it consists of hard wood, which is cut into small billets. Not being able to cut down the trunks of trees, the natives make their billets out of branches about 8 in. long and 3 to 4 in. thick. To convert them into charcoal they dig a hole 8 ft. long, 4 ft. wide, and 15 to 20 in. deep. In this the wood is laid lengthwise, and piled until it reaches three feet above the ground. The wood is then ignited, and when the pile has sunk to the level of the ground it is smothered with earth. After two days the charcoal is withdrawn and put into long panniers, in which it is carried to the smelting site.

Now comes the construction of the furnaces, of which as many as twenty are made if the supply of ore is sufficient. Near a stream a space has been cleared. A dozen small white-ant hills, 12 to 15 in. high, have been collected. The French use the word *termitière* for these ant hills, and this is more precise than our term because termites are not ants and the structures they build are not hills. I shall use the phrase "termite cone." The native metallurgist selects three of these to make his tuyères, or blast pipes; his helpers take an iron rod and bore the cones lengthwise. Several of them are smoothed on one side with a hatchet. Then the founder,[2] before starting to build the furnace, washes his hands and face in a bark decoction prepared by the sorcerer. He alone constructs the furnace, an operation regarded as delicate and mysterious. A space of a yard square is made level. In the center of this the founder digs a basin-shaped hole 15 in. in diameter and 2 in. deep. In this shallow cavity he places a small heap of embers and twigs, to expel the moisture. Then he sets the three tuyères at equal distances around the rim. The ends of the tuyères reach to the edge of this basin, or hearth, which is destined to receive the molten metal; they are inclined slightly toward the bottom. Here I may mention in passing that the term "smelting" is derived from a word meaning grease and that in the smelting operation the ore is rendered liquid like fat in the fire. The termite cones, of course, consist of fine particles of argillaceous material, so that they play the part of fireclay.

Furnace Construction Required Only Half Hour

Four or five of these cones, squared on one side, are now set close together around the hearth; any space between them is filled skillfully with pieces of termite cone; other pieces are arranged so as to crown the structure and carry it to the desired height. When thus completed the furnace is 26 to 28 in. high and from 15 to 16 in. wide. Then this fragile structure is propped with several forked branches 20 to 30 in. long. The general appearance of the furnace is shaky, and one wonders how it holds together. Only half an hour has been spent in constructing it.

The charging is done carefully. If any piece of the furnace breaks away, it is replaced. In the hearth the founder places some charcoal, to the thickness of three fingers; then he piles billets of wood in orderly fashion and as compactly as possible. The furnace is filled nearly to its top. Burning embers are thrown into it and fall to the bottom. The founder, crouching on the ground, blows between the termite cones, and the dry wood ignites. When the fire has taken good hold the billets are covered with three or four fingers' thickness of charcoal, on which the founder places a piece of ritual bark. Then the ore, picked and broken to lumps no larger than a small egg, is charged on top of the charcoal. Usually two trays of ore, weighing altogether 80 to 100 lb., are added. The furnace, already filled with fuel, is too small to contain this charge, so that the beautiful green ore forms a cone on top of the furnace. To hold the malachite in place, the founder raises the edges of the furnace by means of pieces of

[2]The French use *fondeur*, the man who melts metal. I do not use the word "metallurgist," because it connotes scientific knowledge.

termite cone. A plume of smoke waves from each furnace as it becomes active.

Little by little the smoke disappears and the flame begins to lick and blacken the pretty malachite. The fire is left to itself for an hour and a half. The founders sit near their furnaces and discuss the progress of the operation, watching the successive collapse of the fuel and the ore into the body of the furnaces. The blowers use the interval to make their bellows ready for action. With their hoes they raise mounds of earth about 10 in. high in front of each tuyère. On each mound they arrange six feet of green leaves, to serve as a cushion while at work. In front of the tuyère is placed the bellows; it is made of two bottles of antelope skin; each of these has an opening of two inches at one end; and at the other a transverse aperture about eight inches long, the lips of which are rendered rigid by means of rods of bamboo sewn to the hide. The rods are provided with thongs into which the blower passes his fingers, and thus by the movement of his hand he causes the aperture to function as a valve. He lifts the bottle and at the same time admits the air, which he forthwith compresses; then he closes the valve and expels the air at the other end. This is fitted with a tube of green bark, which has been kept in water until the time for using. It resists the heat surprisingly well. The air tube of the two bottles, abutting at the same tuyère, are fixed under a thong that is stretched between two stakes. The bellows are tethered to the ground, and the back of each bottle retains one of the feet (of the original antelope), by which it is tied to a stake. The bellows are worked alternately, first by one hand and then by the other, with a quick movement, so as to produce a continuous current of air.

Meanwhile the fire has consumed the last billets of wood. The heap of ore has sunk into the burning furnace. The founder resumes his duties. He proceeds to patch the breaks in the walls of the furnace. Some clay or the fragments of a termite cone have been mixed with water and beaten underfoot so as to make an adhesive mud. Several lumps of this are applied to the walls of the furnace and serve to close the interstices. The fire still glitters across the cracks, but the blasts of air are practically restricted to the three tuyères. The fire has no outlet now except on top. The furnace is then filled with charcoal to its mouth, and the blowers, posting themselves at their stations, with bodies nude and hands engaged in the thongs of the bellows, await the signal of the founder to complete the smelting operation. He approaches the furnace with a bark bowl containing the ritual water previously prepared by the grand sorcerer; he carries also six bits of bark from the sacred trees. Into each of the tuyères he throws a bit of bark; then with a grass brush he sprinkles the furnace, and finally throws a last bit of bark into each tuyère. Thereupon the excited crowd of natives intones a chant, the rhythm of the bellows strikes the air, and the smelting operation reaches its climax.

Why the Founder's Craft Was Sacred

It is now 11 o'clock at night. The furnaces spit fire, the flames change in color, first to bluish green and then to gold, crowning the furnaces and illuminating the ebony bodies of the natives with a strange brilliance. The fused metal begins to drip into the hearth. The clamor of the crowd increases; the clapping of hands keeps time with the chant. The moment when the beautiful emerald ore changes into a dazzling liquid is one fraught with emotional excitement to these children of nature; to them the mystery of the furnace is not a simple operation in chemistry and physics; it is a manifestation of the power of the spirits of the mountain evoked by their chief. It is the spirits that touch the stones and draw from them the precious liquid, the water of copper. Therefore the founder's craft seems to be a sacred function touched with a mysterious greatness.

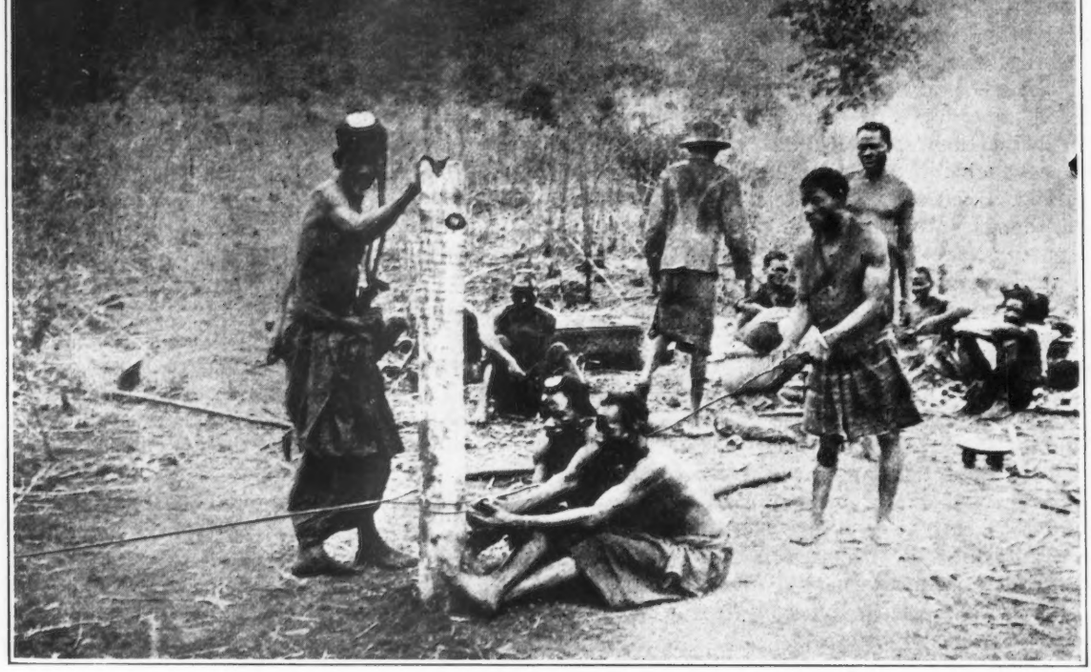
At the end of half an hour of solemn tumult there remains but little in the furnace; the fuel has volatilized, the copper has run into the hearth. The founder, armed with a rod, has been watching the operation; he has added an occasional handful of charcoal; he has caused the ore that sticks on the termite cones to tumble down; he has caused the bellows to be quickened when he thought it necessary. The poor blowers are weakening, their bodies run with sweat, they have shot their bolt. The crowd awaits with anxious curiosity the result of the operation. The founder gives the signal to break the furnaces; half a dozen young fellows armed with poles attack them, overthrowing the termite cones in glowing fragments; they withdraw the cinders and take care to push all the burning embers to one side, for it is necessary for these barefooted people to approach without being burned. At last the lump of copper, bright red, appears like a rising sun. By aid of a scraper made of green bark, and provided with a long handle, the founder sweeps aside the particles of cinders that float on the metal, which itself soon congeals. He assures himself that the copper has solidified, and then, with a few strokes, he detaches it from the hearth, and forthwith by the smart movement of a pole he turns it over on the ground.

Interpretation of Native Methods

If we now consider the technical character of the operation, we note that the process has two phases, the first of which is the roasting or dehydration of the ore,

A smelting furnace in operation. F, the furnace. B, the blow hole. A, the cruciform mold

and the second the reduction to metal. The second stage begins when the furnace is tamped and when the bellows are set to work. This stage only lasts for half an hour. The preceding stage is marked by an open fire, and it lasts for two and a half hours. At first sight one is surprised at the appearance of this rudimentary furnace, made of disjointed termite cones, permitting the air to enter above and below. However, it is adapted to its purpose and involves the minimum of labor. The charge of ore in each furnace weighs about 100 lb. and it averages 40 per cent in copper. About 24 to 28 lb. of metal is obtained, so that the extraction is from 60 to 70 per cent.



The process of wire drawing as practiced by Bayeke tribe

The lumps of copper are carried to the village, where, under the shelter of a group of large trees, the metal undergoes the process of refining. The furnace employed for this purpose is much like that used for the smelting, but it is a little smaller, being not more than 16 in. in height and 10 in. in diameter. It is not tamped with clay, and is operated by means of two bellows only. Charcoal is used by itself, without the further addition of wood. The chief peculiarity of the refining furnace is the earthen vessel that serves as a crucible. This consists of the bottom of a broken pot, having the shape of a basin, eight inches in diameter and about five inches deep. This crucible is carefully lined with wood ashes, fine, and well smoothed. The furnace with its pottery bottom is filled with charcoal. A lump of copper has been broken in pieces by aid of a copper hammer.

From ten to twelve pounds of the metal is introduced at the top of the furnace; it fuses in twenty-five to thirty minutes, and runs into the crucible. Meanwhile the molds have been prepared. They also are made out of a termite cone, that precious refractory material. The cone is planed on one side and on this are made cruciform grooves six to seven inches long and two to three inches wide. These are lined with fine ashes, like the crucible, and dried in a fire. Sundry special shapes of ingots are meant for making hoes and other tools, but the cruciform mold is the most common. It is placed close to the furnace, which is then quickly demolished, care being taken not to upset the crucible. This is seized by a master founder and emptied into the mold. He protects his hands with two pads of tow or with moist rags. The casting is never performed in the sunlight, only in the shade, and, most frequently, in the cool of the evening. In sunlight the metal becomes blistered, so it is said. The ingot ordinarily weighs from four to six pounds.

Primitive Wire Making Was Simple But Efficient

The Bayeke made wire, hoes, and bullets of copper. The making of wire was their specialty, and they made it thus: An ingot of six pounds is heated in the fire of a forge. This is made simply by directing a bellows upon a small heap of charcoal. The heated metal is then lengthened by hammering. (This may be said to take the place of the rolling mill in the modern manufacture of copper wire.) A big piece of hard sandstone serves as the anvil, and the hammer is made out of a lump of copper 5 in. long by 4 in. in diameter. This around its circumference has two deep grooves into which are fastened thongs of supple bark, which end in two loops that the smith seizes in his hands while he strikes the metal repeatedly. For pincers the smith uses green bark that he has coiled himself so as to make it strong enough to hold the piece of red-hot metal without burning himself. Despite the crudity of this equipment, the ingot of five to six inches is extended to a length of 12 to 14 ft. A hundred times heated, hammered, and reheated, the copper yields to the blows. An assistant holds the metal and turns it so that the smith can strike it on each side. Every blow counts.

The copper is elongated slowly, but surely, on the big block of sandstone.

To maintain the continuous effort, the smiths have to be numerous; each time the metal is replaced on the forge a new man steps forth and assumes his share of the task. At the end of the operation the ingot has become a long bar, of irregular thickness, shapeless and twisted. The average thickness is about half an inch. The first thing is to straighten this bar, by hammering. The hammer is a lump of iron, round, without a haft, but pointed at one end and flat at the other. This iron anvil weighs 60 lb. It is placed on the ground. The smith seats himself and strikes the metal vertically, holding the lump of iron in one hand and the copper with the other. At intervals the copper is heated. Thus the bar is rounded and rectified with light blows until it has been lengthened to 18 ft.; it is now ready to be drawn into wire.

To do this, a stake, 4½ ft. long and 7 or 8 in. in diameter, is sunk solidly in the ground to a depth of two feet. To prevent the post from turning, it is rooted by means of a transverse bar of wood that passes through it near its base. The top of the post is notched into a fork, on which astride is placed the bar of metal. One end of it is held fast in a grip made of two pieces of iron 9 by ⅞ in. These are pressed against each other by means of two spiral rings, which are forced over them by aid of a hammer. The copper bar is held so tightly in this grip that it will break before it will slide. The other end of the bar passes through a drawplate, which consists of two pieces of iron of hemispherical shape tapering to a cone and pierced with a hole that can be enlarged or narrowed to the desired calibration. (This corresponds to the modern die.) Behind the drawplate the bar passes through a hole in a lever of strong wood, 6 ft. long and 3 to 3½ in. thick. Thus when the bar rests on the fork of the post one end is in the iron grip, and at the other is the lever, before which is the drawplate. The lever is first set upright, so as to take its fulcrum from the stake; a vigorous pull and the drawplate, previously greased with nut-oil, is forced on the bar and advanced 12 in. The lever is then put in a level position, so that the end takes its fulcrum on the side of the stake.

Annealing Process Simple

Then begins the operation. The men take hold of the lever and force the drawplate over the bar of copper, which rolls itself spirally on the stake as it is drawn out. The performance is picturesque; it resembles a game rather than a task, for the men seem to enjoy it, singing a joyous chant. The copper in passing through the drawplate is lengthened each time to the extent of 4 to 5 ft. Starting at 15 ft. it becomes 45 ft. long, and is now a thick wire, such as the negresses buy for making their bracelets. At each draw the copper is thinned; as it is wound round the post it takes the form of a spiral spring, which can be lifted without untwisting. A fire of straw is lit in a small hole that is dug in the ground; in this the copper is re-heated, and then sprinkled with water so as to give it the required temperature. Thus it is annealed. The wire is then drawn out to a thickness of two millimeters, or about 0.08 inch. Three men suffice for this work. One end is held by the operator, after having made two turns on a post, which serves as a clove hitch. Then the two others hold the drawplate in their crossed hands and pull it toward themselves while the third man gathers the drawn wire on the clove hitch. As before, the wire is frequently annealed and copiously lubricated. At the last stage of the drawing the wire measures no more than half a millimeter. One man performs this drawing by himself. At the beginning of the operation he stands erect, holding the wire with his foot and pulling the drawplate to himself upward. When the wire has become still thinner he takes it in one hand and with the other he causes the drawplate to pass over it. Finally the wire is made into a *mutaga*, a bracelet of wire that has been rolled on a core of supple wood fiber mixed with the hair of goat or antelope.

Permanent Furnaces Used by Lualabas

At the mines of the western district, on the left bank of the Lualaba, the natives do not use the temporary furnaces, such as the Bayeke constructed; they use only one furnace, which is of the permanent type. The malachite is carried to a stream and washed by the women; then it is roasted on a pile of wood. Thus the two operations of roasting and smelting are kept separate. The roasted ore is washed in turn, and then sorted carefully. The reduction takes place forthwith in a furnace, from which they draw small crosses of metal by successive castings. The furnace has a tap hole before which the cruciform mold is placed. These crosses are used as money in trade.

An English mining engineer, Mr. P. K. Horner, told me of similar operations that he saw at Dikulwe several years ago. He found the natives mining malachite occurring in shale. They broke the ore to less than an inch on boulders; then they concentrated it by aid of the wind, pouring the crushed ore from one basket to another. The concentrate was carried in baskets to the river, where the women, standing in the water, jigged it in their baskets, so as to get rid of the lighter gangue and some of the ore. Then the washed ore was roasted on a pile of wood and reduced to a mixture of copper oxide, carbonate, and charcoal. This mixture they put into a little (two or three feet diameter) shaft-furnace made of the ant-hill clay. The bellows were made of antelope skin. The trickle of pure copper that came from the furnace was cast in cruciform molds. The slag assayed 30 to 40 per cent copper, and the ore about 50 per cent. The knowledge of the metallurgic

Making tuyères out of termite cones

technique is retained by the old women of the village, and they are highly regarded. They transmit their knowledge to their successors, members, as it were, of a guild.

In "Livingstone's Last Journals" I find a brief description of the process of wire-drawing as performed by the Unyamwezi, near Lake Bangweolo: "A heavy piece of iron, with a funnel-shaped hole in it, is firmly fixed in the fork of a tree. A fine rod [of copper] is then thrust into it, and a line attached to the first few inches which can be coaxed through. A number of men haul on this line, singing and dancing in tune, and thus it is drawn through the first drill; it is subsequently past through others to render it still finer, and excellent wire is the result." Again, in 1867, on his way from Lake Nyassa to Lake Bangweolo, Livingstone writes: "A great deal of copper wire is here made, the wire-drawers using for one part of the process a seven-inch cable. They make very fine wire, and it is used chiefly as leglets and anklets, the chiefs' wives being laden with them and obliged to walk in a stately style, from the weight. The copper comes from Katanga."

In reference to the melting of the metal, Livingstone says:[1] "The Banyamwezi use a hammer shaped like a cone, without a handle. They have both kinds of bellows, one of goatskin, the other of wood, with a skin over the mouth of the drum, and a handle tied to the middle of it: With these they smelt pieces of the large bars of copper in a pot, filled nearly full of wood ashes. The fire is surrounded by masses of ant hills, and in these there are hollows made to receive the melted metal, which is poured while the pot is held with the hands, protected by wet rags."

He recognized that the copper crosses had no religious significance. In 1871 he saw several of them, and then wrote in his diary: "The cross has been used—not as a Christian emblem certainly, but from time immemorial as the form in which the copper ingot of Katanga is molded; this is met with quite commonly; and is called *handiplé mahandi*."

In this region, as elsewhere, the smelting of the ore was preceded by a long period during which the native copper was used for making implements, by simply treating it as soft stone and hammering it into shape: The outcrops contain native copper. Thus we see that the mining and smelting of copper in the Katanga is typical of primitive methods in other parts of the world. It is an excellent example of the first use of metals by the forerunners of civilization.

Postscript: In this journal under date of Nov. 21, 1925, George L. Walker describes the old copper workings of Central Africa in an entertaining manner. He lays excessive emphasis upon the size and antiquity of the native workings; so it seems to me, after having seen many of them myself, the word "ancient" ought to be used discreetly; to an archaeologist it means B.C. It would be well if "ancient" could be restricted in its use so as to refer exclusively to the period before the Christian era. Mr. Walker's reference to the statement in "Purchase's Pilgrimes" is to the point, but, after discussing the matter with Messrs. F. E. Studt and Robert Williams recently in London, I think it safe to assert that the copper exported at the beginning of the seventeenth century from Bangweolo must have come, not from the Katanga but from Bunbe, in northern Angola, where copper ore in the form of malachite has been worked for more than a century, and probably as much as two hundred years ago. I know of no evidence to justify any higher antiquity for copper mining in Central Africa.

[1] "Livingstone's Last Journals," Edited by Horace Waller; p. 256.

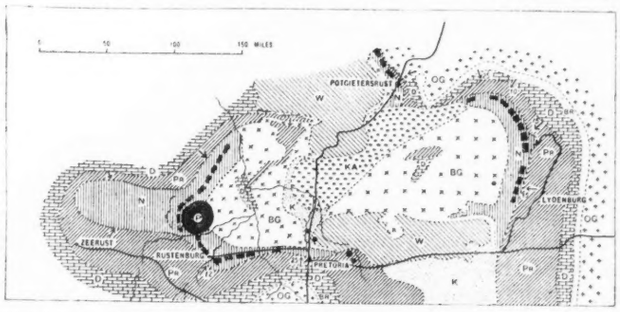
Platinum in the Rustenburg District, Transvaal

By A. W. Newberry

PLATINUM developments in the Rustenburg district of central-western Transvaal lately have rather overshadowed those of the Lydenburg and Potgietersrust fields. The platinum horizon, similar in character to the Merensky horizon of the Lydenburg district, was found in the neighborhood of Rustenburg toward the end of 1925, and by the first of August, 1926, it had been shown to extend, allowing for certain large unprospected areas, from Farm Elandsfontein No. 374 near the western edge of the Pretoria district westward to Rustenburg, then northwest around the Pilandsberg, and finally northeast to Farm Swartkop No. 355, a total distance of 120 miles.

Throughout practically its entire extent, the outcrop, or more properly "sub-outcrop," is found along a broad valley concealed by 3 to 8 ft. of black turf soil. The accompanying rocks are norite, anorthosite, and pyroxenite, as in the Lydenburg and Potgietersrust districts. The Pilandsberg, just referred to, is a nearly circular massif of nepheline syenite and allied rocks which intrudes the basic portion of the Bushveld Igneous Complex. It is roughly 16 miles in diameter and stands about 1,000 ft. above the surface of the surrounding country. Only a few exposures of the platinum horizon have been made in the vicinity of the Pilandsberg, and these exhibit marked irregularities in strike and dip. The nature of the platinum carrier varies to a considerable extent in other parts of the district, but the strike and dip are remarkably uniform over long distances.

The most advanced development is on farms Kroondal No. 177 and Klipfontein No. 538, east of Rustenburg.



Geologic sketch map of a portion of the Bushveld basin

OG—Old granite; BR—Black reef; D—Dolomite; Pr—Pretoria series; W—Waterberg system; N—Norite; BG—Bushveld granite; Solid black circles—Nepheline rocks (P—Pilansberg complex); K—Karroo system; KA—Bushveld amygdaloid.

Here up to Aug. 1, 1926, more than 1,400 ft. of underground work had been done. Six inclines have been put down on the reef to depths varying between 100 and 300 ft. A vertical shaft has been sunk to intersect each of the inclines at a depth of 65 ft., corresponding to 300 ft. measured along the dip, and some driving has been done at this level. The deposit will be mined entirely by underground methods in spite of the flat dip,

Camp at Schildpadnest, 78 miles north of Rustenburg. The most northerly exposure is about 2 miles beyond

Main workings at Farm Doornspruit No. 878, 11 miles northeast of Rustenburg. Note the black soil that covers the reef

which renders a large tonnage close to the surface available by stripping and quarrying. Large open workings in so flat a terrain would necessitate the handling of much water during the rainy season, so the greater expense of underground mining is probably justified.

The average of all underground development sampled up to July 1, 1926, on these two farms was 5.3 dwt. platinoids over a width of 3 ft. 3 in. The limited amount of work at the 300 level showed 6.2 dwt. over 2 ft. 6 in., indicating a restriction of the platinoid content to a narrower width as depth is gained. The footwall mineralization appears to diminish somewhat with increasing depth.

Taking the district as a whole, the platinoid content is remarkably uniform. One company reports 5.09 dwt. over 4 ft. 6 in. as shown by trenches and pits at intervals of 100 yd. for a distance of 6 miles along the strike. Another with deeper workings not so closely spaced reports an average of 5.8 dwt. over a width of 3 ft. 2 in. for a distance of 3½ miles. And so on throughout the district wherever the workings are spaced sufficiently close to permit an estimate of average value.

Oxidation extends in most cases to a depth of 30 to 70 ft. Where the mottled anorthosite constitutes the ore horizon, however, oxidation rarely extends below 20 ft. and blebs of fine-grained sulphidic matter are sometimes found within 10 ft. of the surface. Although there are still too few exposures below the zone of oxidation to permit a definite conclusion in regard to the platinoid content of the unoxidized reef matter, there appears to be very little difference in this respect between the oxidized and unoxidized portions of the reef.

With only eight months of prospecting on which to base an estimate, it seems fair to predict that at least one-third and probably much more of this 120 mile line will be found to average 5 dwt. platinoids over a width of three to four feet. This is considerably higher than the average for the Lydenburg district, although the width is slightly less. A comparison with the Potgietersrust district is more difficult because the latter is a region of oreshoots rather than a continuous ore horizon. Although the Rustenburg occurrence persists over a far greater distance, no single section of it, in my opinion, has the economic importance of the Vaalkop-Zwartfontein section in the central part of the Potgietersrust field.

The south half of the Rustenburg district is well served by the Pretoria-Boshoek branch of the South African Railways. If this branch had been located with the express purpose of giving access to the platinum horizon, it could scarcely have been placed more advantageously. The development of the north half of the district will be hampered to some extent, in the rainy season at least, by poor transportation facilities, as it is very difficult to maintain a satisfactory road over the black turf in wet weather.

Work was begun in August, 1926, on one unit of the first reduction plant. This unit, which is to have a capacity of 5,000 tons of oxidized ore per month, should be in operation early in 1927.

Discussion

The Situation in Mexico

THE EDITOR:

Sir—I have just returned from Mexico City after a stay of two months in the republic and a journey of some 3,000 miles. I entered the country at Laredo, passed through the cities of Monterey, Saltillo, San Luis Potosi, Mexico, Queretaro, Aguas Calientes, Zacatecas, Torreon, Chihuahua, and re-entered the United States at El Paso, Texas.

I met no violence, and to the casual traveler everything is serene. A military guard accompanies every train, and an extra carload of guards was switched onto our train at Chihuahua City and continued so to the border. The Mexican Central Railway, from Chihuahua to the border, passes through a semi-arid region that is sparsely settled and that has been the scene of numerous train hold-ups and attacks from *revoltistas* and bandits in the past. It appears, however, that the more than usual precautions were taken in the present instance because of apprehension due to the reported presence in the region of "General" Fernandez, who, at the head of a small band of men, is reported to be initiating the long-heralded revolution of Adolfo De La Huerta against Calles and his government.

De La Huerta is quoted in news dispatches from Tucson, Ariz., as saying that, had he arms and ammunition, he could command one hundred thousand men to fight against the Calles regime.

In spite of the fact that De La Huerta does a great deal of his fighting orally, everything points to an impending conflict. The Yaqui revolt in the west, with its battle cry of "Viva De La Huerta!" and the numerous raids and attacks by bandits and *guerrillas* in the populous southern provinces and in the mining regions of the southwest, with the religious struggle as camouflage for political and anti-social ambitions, are keeping the federal forces, which number but 45,000 men, fairly well employed.

Calles apparently made a political error when he sought to enforce the religious laws, as in so doing he alienated the common people, endangered the loyalty of the army, and played directly into the hands of his enemies, the financial interests and the old aristocracy of Mexico. Calles' action in the matter, however, is what might have been expected from the idealist which he is, rather than from an opportunist bent on furthering his own private fortunes at the expense of the welfare of the masses of the country.

A Mexican gentleman high in the councils of the leaders of the Mexican revolution told me in 1924 that when Obregon became president in 1920 an agreement was reached by him, Calles and De La Huerta, that they should rule Mexico among them, as long as the welfare of the country required, or their own ambitions remained unsatisfied. Of the three men, Calles was probably the ablest and most unselfish. Obregon was the soldier, and because of his paramount military services was given his turn at the presidency first. Calles, the idealist and reformer, was to succeed Obregon, after which De La Huerta, the self-seeking politician and scion of Mexican aristocracy, should have his turn.

Obregon served his four-year term as president, when, according to the agreement, the election was to have been manipulated in favor of Calles. De La Huerta, however, was growing hungry, and besides his blue blood took on a deeper tinge at the thought of Calles, the commoner, taking precedence over him. De La Huerta broke the gentleman's agreement, and initiated the revolution of 1924, which was short-lived, and he was forced to flee from Mexico. Since that time all reports show him plotting against the government of Calles and awaiting his opportunity to overthrow it. That opportunity seems at hand. It is not improbable that De La Huerta will have the support of the Catholic Church, which will welcome the opportunity to retrieve ecclesiastical property worth half a billion pesos.

Calles' enemies — Mexico's enemies, that is — shout "Bolshevik!" and assert that he takes his orders from Moscow. Such assertion is patently absurd and is pure propaganda put forth by interests which would gain by the overthrow of Calles or the intervention of the United States. These interests have persistently sought to bring about war between the United States and Mexico for the last fifteen years.

So much for the internal situation. Mexico's external relations are in a no less precarious condition. Foreign concessionaires, mostly citizens of the United States and England, holding and profiting from land, oil and mining rights, refuse to abide by the new code which goes into effect the first of the year. These interests claim confiscation and invoke the protection of their governments for what they claim to be their rights. This matter was the cause of a sharp exchange of notes between Mexico and the United States during the latter part of November. As a barometer of the gravity of the situation, Mexican silver pesos dropped from 48 and a fraction to 39c., entailing great financial and business depression. When this depression was at its worst, a conciliatory expression came from the Mexican embassy in Washington, and the peso started to climb back to its normal level.

Another bone of contention between Mexico and the United States is in the Nicaraguan question. The United States has definitely taken the attitude that she will protect her ambitions and rights in the matter of the Nicaraguan Canal route. This policy resulted in pointed diplomatic notes with Mexico, over filibusterers from that country supplying arms and ammunition to the Nicaraguan rebels. The statement was published in Mexico City newspapers that Mexico would recognize and support the rebel government to be set up by Sacasa in Nicaragua. Such an act would be a slap in the face of the United States and could only be construed as a declaration of war. This crisis is in abeyance, pending the outcome of events in Nicaragua.

Kingman, Ariz. F. LE R. T.

Bolivian Tin Veins

THE EDITOR:

Sir—To explain the phenomenon of unequal distribution of tin in depth, in the San Fermin de Llallagua vein, Mr. Koeberlin has advanced the idea of regional enrichment, appealing to the possibility of solution and redeposition of cassiterite, a mineral which in my judgment is more refractory in this way than is quartz. In his arguments Mr. Koeberlin has considered only temperature, omitting the factor of pressure.

Let us reconstruct in imagination the surface of the tin-bearing district at an elevation similar to that which obtained at the epoch when the veins were formed, and compare it with the present surface and further with the underground depth where the veins are now worked, and we will see that the formidable effects of erosion produced by the action of the elements has amounted to one, two, or more meters vertically, if we admit that even the most elevated peaks which today dominate the ranges must have lost something of their elevation. Consequently, the original veins in their wall rocks at the horizon now exposed to view inclosed enormous hydraulic columns that could not have failed to exercise a decisive influence upon the sudden changes between the liquid and gaseous states of the ascending solutions. I believe that in certain wall rocks the conditions are wonderfully favorable for the elimination of the salts to such an extreme that the solutions at one operation divested themselves of one portion of their load and continued their course upward with the residual composition. In this way a tin vein of medium grade might have had a transition to a prodigiously rich condition in a limited zone, and terminate in a barren outcropping zone. This would be a natural change, without difficulties due to pre-existing conditions.

On the slopes of the mountains and in the beds of the streams one stumbles over boulders and good-sized masses, now of solid ore, now barren of cassiterite, which in size surpass considerably the ores now taken from the mines. Undoubtedly they are derived from those favored deposits, which, broken up by the elements, have worked down into the alluvium, and, thanks to their volume, have been able to resist being transported by water.

Advice and general formulas are dangerous for the miner. Insignificant indications encourage study and investigation of unexplored regions; it depends upon the judgment of the operator where it is wise to carry on his labors. Tin has been found in many regions where no one would suspect it; in others people have come to ruin, searching for it in vain.

Oruro, Bolivia. JOSE JACKOWSKI.

As a Lawyer Sees Mining

THE EDITOR:

Sir—In the issue of the *Engineering and Mining Journal* dated Dec. 4, 1926, I have read the article written by an attorney at law, J. E. Russell, of Prescott, Ariz. That locality was my old stamping ground for many years, while Arizona was a territory, and, believe me, he tells the truth. In my twenty-five years of practical mining I have met a lot of mining scouts such as he refers to, and since my time in Arizona I have spent some sixteen years here on the West Coast of Mexico, operating for different mining companies, and through the worst of the times during the revolution. As to these cigar-stand mining scouts, there were a lot of them. The grafters came down to this coast, trying to tie up mining prospects that showed the earmarks of making a good property, and had the gall and good will to offer the owner 20 per cent of the value of the price that the owner offered to sell for, which was a low price at that on account of the times. Moreover, they wished to pay nothing down on the option and the option was to be for a year or more, so that they might go back to the States and find some one with money to take a chance with them on a 50-50 basis. If they got the money they never showed up in Mexico.

This is what has hurt the mining development of prospects on the west coast of Mexico. There are some good prospects found on this coast. As yet the west coast is a virgin mining district, just as Arizona was in the early days, and now it looks as if Mexico had settled down to business, so that there is possibly a chance for the prospector to get out and look up new properties. Prospecting in this country is not like prospecting in the States, as the country is covered with timber, low brush and grass so that you cannot see or make out just how the formation is or lies, until you have stumbled on to a prospect and cleared off the timber or brush, which is a tangle. In a few parts of the country you may find open ground in which to prospect.

I have a very good group of prospects with a lot of work done on them, showing very good values in gold and silver on the average. All of the ore veins are of good width, 4 to 8 ft., and the shafts are making plenty of water for milling for a plant of 50-ton capacity at the present depth. At present there is ore sufficient for a 20-ton mill. This property lies within 5 miles of the railroad. At a very small cost an automobile road can be built from the railroad to the property, with no grades over 5 to 7 per cent.

Like a good many others, I have no ready capital to work the property as it should be worked in order to put it on a paying basis. I have had some offers by some of these grafters, but have turned them down, as they did not mean business.

Yago, Nayarit, Mexico. W. J. FERRIS, P.M.E.

Editor's Note: P.M.E. is assumed to mean Practical Mining Engineer.

A D. & L. Ignition Furnace Using Wood for Fuel

THE EDITOR:

Sir—I have noticed in some of your recent issues some discussion of ignition furnaces for Dwight-Lloyd sintering machines. This was of considerable interest in that it was shown that other fuel than oil was being used at several points. Perhaps the general understanding is that oil is by far the most superior type of fuel.

In one issue an account is given of a type of furnace where excellent results are being obtained using coke, the furnace being of special design. Many of your readers will perhaps be interested to know of the use of wood at our copper-smelting plant. The type of furnace used in each of the two 42x264-in. sintering machines follows very closely the design shown in your issue of Sept. 11, except that forced blast is not used,

the ash door being removed and the opening increased to 6x12 in. Oil in this section is almost out of the question, owing to its high cost at the coast and high transportation costs inland. It cannot be had for less than 1½ to 2 cents per pound. But the wood supply here is satisfactory, there being a variety of hard-woods, many of them of remarkable calorific value. Of these woods, one known as Retamo was selected because of its good flaming properties and high content in volatiles. As received here it has a calorific value of 8,500 B.t.u. per pound and costs $4, United States currency, per metric ton.

The cordwood sticks are cut once in a crosscut saw to about 18 in. length and placed in the firebox so that one end projects a few inches over the bridge wall of the furnace. The radiant heat from the low furnace roof generates gas from these pieces, only a few of which are put in at a time. Although the flame is at times somewhat smoky, the ignition is immediate and the resulting sinter of a highly satisfactory character. Material entering the feed end of the machine averages 25 per cent sulphur and the discharged cake, a solid block the full width of the pallet and often two pallets in length, averages 4 per cent sulphur. With this degree of desulphurization, the speed of pallets is from 12 to 15 in. per minute, with a 4½-in bed. The consumption of wood is quite low, being at present 10 kilos per metric ton of sinter produced.

Under normal conditions two pieces of wood are placed on the grates every ten minutes. Ashes falling through the grates are collected on the plate ten inches below and shoveled from time to time over the ore-bed. The flame produced is not so intense as that from oil or coke, but temperatures from 1,100 to 1,400 deg. F. are maintained.

As this Retamo wood grows within a few miles of the smelter, its adaptation as fuel for the ignition furnaces has been a great advantage in our operating costs. It might also be of interest to note that short Retamo blocks about 6 in. diameter and 6 in. long are being used to replace imported coke in the blast furnace where copper ores are being smelted.

Chilecito, La Rioja, Argentina. THEO. L. JOHNSON, Superintendent.

Consultation

"Side-bump" vs. "End-bump" Tables

"What are the comparative merits of the so-called side-bump and end-bump concentrating tables?"

This question is discussed briefly by Richards and Locke in their "Text Book on Ore Dressing," from which the following notes are taken: The tables with the side bump throw all the particles toward the side, while the water current rolls them down hill at rates varying with the size of the grains and their specific gravity, the larger and lighter grains moving faster than the smaller heavier grains. The combination of these actions yields the particles spread out like a fan, and it follows that the table can turn out concentrate, middling, and tailing; or it may yield more than three products—for example, galena, pyrite, sphalerite, and quartz, each mineral being guided into its own catch box. The end-jerking tables, on the other hand, separate the particles into layers, then by the jerk throw them toward the head end, and between the jerks the water rolls the grains in the top quartz layer toward the tail end. By rightly adjusting the slope, the pyrite is jerked uphill and the quartz is rolled down hill. It follows that machines of this class can make only concentrate and tailing; and if it is desired to make middling, with a view to producing cleaner concentrate, or to make a three-mineral separation, then two tables must be used, one following the other. The first will yield the galena, for example, as concentrate, and the sphalerite and quartz will go together into the tailing. The second table, re-treating this tailing, will make a concentrate of sphalerite and a tailing of quartz.

Minerals at Randsburg, Calif., and Rifle, Colo.

"Can you give me any information relative to the following: What is the nature of the gold and silver ore mined at the California-Rand mine at Randsburg, Calif.? I recently received several specimens showing particles of a metallic appearance, pale yellow in color, scattered in a grayish rock, and am particularly interested to know whether it is likely to be petzite, as tellurides have been reported from Kern County. What is the nature of the black vanadium ore disseminated in sandstone and mined by the United States Vanadium Co. twelve miles north of Rifle, Colo., as well as the low-grade green vanadium mineral occurring at the same place? The latter does not appear to be roscoelite."

According to Carlton D. Hulin, geologist, of San Francisco, the ore minerals in the California-Rand deposit are miargyrite, stylotypite, pyrargyrite, and proustite, in a gangue of fine-grained quartz, with calcite and chalcedony.

Frank L. Hess, of the U. S. Geological Survey, has identified the green mineral in the vanadium mines near Rifle, Colo., as roscoelite and the black mineral as kentsmithite.

Uses of Tin

"Can you give me an approximate allocation of the total tin consumption of the United States to different industries?"

The most recent survey of this kind of which we know is that made by the War Industries Board, covering the year 1917. That there have been some considerable changes in the proportions used for each of the important purposes is possible, but the figures are given for what they are worth.

	Long Tons	Per Cent
Tin plate and terne plate	27,600	36.20
Solder	17,000	22.30
Babbitt and bearing metal	10,800	14.16
Brass and bronze	4,800	6.29
Collapsible tubes	2,100	2.75
Foil	4,000	5.24
White metal	1,750	2.30
Tinning and retinning	1,900	2.50
Chemicals	1,700	2.22
Plated and Britannia ware	1,000	1.31
Miscellaneous	3,607	4.73
Total	76,257	100.00

News of the Week

Summary

PRESIDENT CALLES of Mexico delivers New Year's day address, outlining policy; improvements cited; "Red" propaganda decried; unjustifiable mistrust pointed out.

Applications for Mexican mining concessions decrease —Grand Central reports progress—Sunnyside shaft sinking nine feet per day.

New Utah-Apex flotation plant—Cripple Creek more active—Portland Gold discovers large oreshoot.

Safety award for Federal Mining employees—Oil mining vs. drilling in Canada.

Lightning Creek Gold sues government for $10,000,000—Alaska placer mining on upward trend.

German zinc cartel dissolved — Diamond syndicate strengthened—South African mineral production has large increase—Largest mercury deposit in Spain.

Ontario gold production shows increase; dividends larger; stock markets active; power expansion under way.

Belmont Copper completes titles to consolidated holdings—Colorado mining men oppose National Park extension.

Excess stockpiles at Michigan iron mines—Profit from waste dumps in Joplin-Miami district.

New Italian Petroleum Institute—Trail smelter men receive bonus on Jan. 1.

Newfoundland Trying to Relieve Unemployment as Iron Mines Face Shutdown

The Government of Newfoundland has recently been directing its best efforts toward a continuance and increase in the workings of the Bell Island iron mines, according to a report made public by the U. S. Department of Commerce. Back of these efforts lie the serious unemployment situation in the Dominion, a growing dissatisfaction among the fishermen at the unprecendented low prices obtained for the 1926 catch of codfish, and the cessation of work on the road-building program in the Avalon Peninsula.

The Bell Island mines lie in Bell Island, Conception Bay. They provide labor under favorable conditions for fully 1,000 men living in the villages along the shores of the bay. The mines, which are owned by the Dominion Iron & Steel Co. of Sydney, Nova Scotia, are capable of an annual output of 1,000,000 tons of high-grade hematite, but labor conditions and demands for rails and other steel products have resulted in a steel output of 65 per cent for 1926, compared with 100 per cent for 1925.

With the lessened demand for steel, all of the slopes of Bell Island have been closed down except one, and the Dominion Iron & Steel Co. has notified the Government of Newfoundland of the proposed closing down of the mines entirely from Dec. 18, 1926, until Jan. 8, 1927, when it is proposed to reopen the slope now being operated and possibly two more slopes now inactive, if orders for rails are increased at the beginning of the year. This declaration has brought a great deal of disappointment for Newfoundland, for the government had hopes of prevailing on the Bell Island owners to continue to increase their workings, in consideration for placing an order for 15,000 tons of rail for the Newfoundland railways with the Sydney company. A similar rail order was placed last year in England, but the requirements for 1927, estimated at 15,000 tons, have been held up by the government in the hope that the order would provide a bargaining consideration for relieving the unemployment situation in Newfoundland.

Anaconda Operating at Capacity

Zinc Plant Increases Output—No Raw Copper Shipped From State During Year

The plants of the Anaconda Copper Mining Co. at Great Falls are working at full capacity, and these include the zinc electrolytic and the rod and wire mill. The zinc electrolytic plant has increased its output considerably, and the same statement applies to the copper rod and wire plant. In the latter the orders ahead extend for several months from the Western Union Telegraph and other concerns using copper wire.

It is stated that the copper supply is low, and though Anaconda has not shipped any red metal from this state during the year, requiring its entire production for home consumption, it is predicted that with the demand for the copper early in the year from Germany, France, and England some of the idle properties will have to be reopened to meet the increased demand. Altogether the outlook for the mineral industry is much more encouraging than at any time in the last eight years.

Advices received at Great Falls state that a party of New York capitalists was due there on Jan. 6 to inspect mining properties in which they are interested. The properties include the Otisco and the Butte Hill Copper Co. It is said that the reports received have convinced the Eastern interests that plans for extensive development should be started at once.

Large Companies Buying Low-Grade Ore Lands in Joplin District

The larger companies are fast tying up the most promising acreage in the Joplin district. Federal Mining & Smelting, the largest producer of the field, has an option on the White mine, for which it agrees to pay $250,000 if drilling proves favorable. In addition, the Federal has leases on 6,000 acres of land at Granby, the property of the American Zinc, Lead & Smelting Co. A concentrator was built on the land early in the year, and a good production has resulted. The Federal has several thousand acres of land leased in the old Duenweg and Spring City districts, formerly large producing sections before the discovery of the Picher district.

The Kansas Exploration Co., a subsidiary of the St. Joseph Lead Co., which purchased the Ritz lease, near Cardin, Okla., at a public auction held in Miami early in the year, for $105,000, has more than 50,000 acres of undeveloped mining land in Missouri under lease.

The St. Louis Mining & Smelting Co., which was one of the three largest producers of the field during 1923, 1924, and 1925, but which has dropped out of the thirty leading producers of the district, is actively developing a large acreage near Baxter Springs. It has several hundred acres under lease, and expects to build a large mill if underground development work proves satisfactory.

Canadian Lorrain Starts Mill

Production of silver has been started by the Canadian Lorrain Silver Mines, Ltd., at Silver Centre, Ontario. Milling operations were held up for some time by delays in delivery of part of the equipment and other difficulties.

New Utah-Apex Flotation Plant

Makes Four Products—Recovery, Lead 90 Per Cent; Copper, 85, and Zinc, 70—Capacity 750 Tons Daily

By Gail Martin,
Salt Lake City, Utah

THE new selective flotation plant of the Utah-Apex Mining Co. at Bingham, Utah, exemplifies the remarkable progress achieved in metallurgy during the last five years. Several unique features are embodied in its construction and its flow sheet. It is probably the only mill in the country that is making four products: A copper concentrate carrying 25 per cent copper and 3 per cent lead; a lead concentrate assaying from 50 to 55 per cent lead and 4 per cent in zinc; a zinc concentrate assaying from 50 to 52 per cent zinc and 1½ per cent lead; and an iron product carrying 40 to 45 per cent iron and from 3 to 5 per cent insoluble.

The mill is one of the best examples of the compactness with which the modern flotation plant and its equipment can be constructed as compared with the old concentrating plant. Though the narrowness of the canyon has complicated the problem of arranging in an economical manner the various units of the mill, this handicap has been overcome in an admirable manner.

New mechanical features are included in the Utah-Apex mill. Simpson crushers, a type new in the state, have been installed. Genter thickeners, the only ones of their kind in Utah, are operating. MacIntosh flotation cells are being used for the first time in Utah. This type of flotation machine is believed to combine several desirable features, including lower power cost, by reason of use of air at lower pressure and less volume; steadier operation, because blinding of the canvas blankets through mineral corrosion is obviated and practically twice the capacity of the Callow cell per square foot of floor space.

From the standpoint of profit to the Utah-Apex Mining Co., the new plant promises to be a big asset. Through its operation ores that previously could not be exploited on an economic scale are being mined. Large depostis of ore carrying from 5 to 10 per cent lead and from 2 to 5 per cent copper have been opened up. This ore is being treated by flotation and 90 per cent of the lead and 85 per cent of the copper, it is estimated, is recovered. Were it not for the mill, this grade of ore could hardly be mined profitably, and if it were, the copper would probably be a loss by ordinary smelting methods.

Ores containing only 3 to 4 per cent lead and from 2 to 3 per cent copper can be handled profitably. This type of ore contains but little zinc, but runs as high as 25 per cent in iron, and from .05 to .1 oz. of gold and from 3 to 5 oz. of silver to the ton. Recoveries on lead-zinc ore are expected to average about 90 per cent of the lead and 70 per cent of the zinc. Ratio of concentration on lead ores will be five and a half or six tons of ore to one of concentrate, and of zinc, eight to one.

The coarse-crushing department of the mill has a capacity of 1,000 tons daily, and the fine-crushing department 750 tons daily. The flotation department is capable of treating 750 tons daily—400 tons of lead-zinc ore and 350 tons of lead-copper ore.

View of Utah-Apex plant looking down Bingham Canyon

New selective flotation plant in foreground; filtering plant, right background; Utah Copper mine in far background.

Cripple Creek District More Active

As a result of the Nickolai-Benson strike at Cripple Creek, Colo., all available acreage on Mineral Hill has been taken up. L. Stewart Cox, county assessor, Cripple Creek, has secured a lease on the Laura Lee and a number of other adjoining claims, all containing a portion of the main contact, and announces that he will start operations as soon as his leases have all been signed. Cox is being backed by a number of Denver men. A new oreshoot is reported at the Portland mine.

President Calles Delivers Message to His People on New Year's Day

National Security, Social Uplift, and Education Main Themes—Foreign Capital Welcome

Mexico City, Jan. 1. — President Calles in a New Year's Day address to the Mexican people said in part:

"The adoption of methods and systems for the development of our natural resources and the defence of our just national rights—methods and systems with which the most civilized countries of the world have successfully strived for their economic and political independence and their prosperity and full development—have aroused, by means of suspicions and oppositions inherent to every innovation, internal and external difficulties; and the policy of strict compliance with and enforcement of the fundamental laws of the country has necessarily started the action of antagonistic forces. Fortunately the points in discussion abroad have been dealt with through channels and by means corresponding to a clear technical discussion. The domestic agitations and oppositions have not succeeded in disturbing fundamentally the public peace, the government being able to comply strictly with all its external and internal obligations without stopping the reconstructive movement that since my coming into power I decided to undertake.

Improvements Cited

"Thus, in spite of numerous and complex handicaps such as are all of political and social character, the financial stability of the country was placed upon most firm bases during last year, by means of a strict policy of economy and moral administration; an extensive educational program for the year 1926 was fully carried out. The central agricultural schools which have been planned were duly completed; a number of irrigation projects were accomplished and others begun and plans for those to be constructed during the new year have been fully prepared; the selection, moralization, outfitting, and equipping of military establishments have been continued and the work of reorganization and efficiency of other executive offices has not been delayed, thus striving, through the united action of all, for the economic betterment of the country and the social and moral upliftment of the Mexican people, which constitutes the most earnest aim of my administration.

"Red" Propaganda Decried

"Unfortunately, these purposes of redemption and economic and social betterment of the great masses of people, without detriment to the just guarantees and prosperity of the privileged classes, through lack of understanding, or bad faith, or natural ill-feeling of selfish interests, have been interpreted as expressions of a program of social disintegration. A rancorous press campaign has striven to represent Mexico as the follower or supporter of exotic forms of government and a disseminator, at home and abroad, of political and social systems wholly strange to our environment and our tendencies.

"Firm, as I am, in my conviction that truth shall necessarily come to light, I have continued serenely in my task without heeding the calumnies and the insults hurled upon me. I have confined myself to state, whenever the opportunity came, that our problems, similar in their nature to those of all peoples in a stage of formation, present in Mexico a phase of our present condition for the consideration of which it would be illogical to resort to foreign measures of which we are accused, and the usefulness of which in social environments different from our own is not for me to comment. For I am well aware that they are neither applicable to the conditions of our country, nor fit our political organization, nor to the unalterable policy of my administration.

Unjustifiable Mistrust

"Due to the unavoidable resistance of the antagonistic forces and interests mentioned above, a natural result has been the arousing abroad of unjustifiable mistrust, notwithstanding that up to this day no harm has been done to any material interests through the policy adopted by this government, notwithstanding that I have repeatedly expressed my purpose not to interpret the Constitutional Laws of the country in any manner that would injure legitimate interests established in Mexico when those laws were enacted. On the other hand, I am willing, naturally, to accept the decisions of the Supreme Court in cases arising from a conflict of interests, and I insist that only an insidious propaganda of inimical interests and the natural distrust of capital have been able to restrict or delay the benefits accruing from co-operation between Mexico and the other countries, whose moral energies and capital shall always be welcome in our country with the sole restriction of respect to our laws and the sole limitation that the external collaboration must not become an absorption, in prejudice to our national interests. . . .

Army Officers Loyal

"Notwithstanding the criminal machinations to alter peace and the insinuations made to army officers to pervert the noble aims of this national institution, preserver of the security and honor of the country, all its members have continued to this day in perfect discipline within the limits established by law, and my government firmly hopes that they shall thus continue for the prestige of the army and of the republic. But should the interest and hatreds intent upon reopening a new era of internal disorders, succeed in obtaining that treason, tarnish what ought to be the highest and noblest of all the institutions, my government is certain that the guilty shall receive immediate and just punishment.

"In order to attain an extensive material and moral development of the country as well as a true collective prosperity, I asked in my message of Jan. 1, 1926, for the earnest co-operation of every Mexican who, forgetting ill feelings or personal ambitions and with his thought bent upon the welfare and prosperity of Mexico, would wish to be with us.

Mexican Welfare Foremost Thought

"The passionate feelings and ancient hatreds stirred last year by unconscious or malicious persons or by mere puppets in the hands of domestic or foreign interests would perhaps now render utopic a similar general call. But having in mind above all the welfare of Mexico, it is my wish to insist on such a call; that all those who are still able to emancipate themselves of malevolent influences, and those who through generosity or patriotic feeling are able to free themselves of the heavy burden of prejudice, selfish interests or hatreds, come to us and willingly accept as legitimate the aspirations of the rightful upliftment of the masses of our country, for which we have always struggled. Only on the welfare of the great masses can a basis for a definite peace be established and prosperity be promoted."

Mineral Production in Alaska in 1926

THE U. S. Department of the Interior announces, through advance statements prepared by the Alaskan branch of the Geological Survey, that mines in Alaska produced minerals to the value of $17,490,000 in 1926, as against $18,220,692 in 1925. The total value of the mineral output of Alaska since 1880 is over $570,000,000. The figures for 1926 are estimates and subject to revision.

Value of Mineral Output of Alaska in 1925 and 1926

	1925	1926 (Estimated)
Gold	$6,360,281	$6,620,000
Copper	10,361,336	9,500,000
Silver	482,495	420,000
Coal	404,617	400,000
Other minerals (lead, petroleum, marble, tin, and platinum)	611,963	550,000
	$18,220,692	$17,490,000

Silver Shield Shaft 900 Ft. Deep

The shaft of the Silver Shield Mining & Milling Co., Eureka, Utah, has been sunk to a depth of 900 ft., where it penetrated the Tintic quartzite, which forms the footwall of the orebodies of the Tintic Standard and other mines of the East Tintic mining district. The main ore channel of East Tintic strikes northeasterly and passes from the Iron Blossom through the Crown Point, Tintic Standard, and the Silver Shield projects. The Silver Shield is surrounded by claims owned by the Tintic Standard. Silver Shield's 900 ft. level has within 180 ft. from the shaft opened up ore in every way analogous to that in the Tintic Standard. So far the ore is low grade, with occasional high-grade bunches and streaks.

News From Washington

By Paul Wooton
Special Correspondent

Appropriation for Manganese Investigation Asked—Potash Act May Be Changed

Senator Shipstead, of Minnesota, has proposed an appropriation of $50,000, to be expended by the Bureau of Mines over a period of two years, for additional experiment work in co-operation with the University of Minnesota on manganiferous iron ores. Some experimentation has been in progress at the Minneapolis station of the Bureau of Mines in an attempt to produce commercial manganese from the low-grade manganese-bearing iron ores of Minnesota, especially those of the Cuyuna range. Senator Shipstead is practically certain that the Bureau of the Budget will approve of this expenditure, and expects a request for a supplemental appropriation will be forwarded to Congress this week. This appropriation will enable the Bureau of Mines and the University of Minnesota to experiment in the treatment of silicate and carbonate ores of manganese by some wet method. The approval of the appropriation is expected by the War and Navy departments, because manganese is an important war mineral.

On account of the great local interest in Colorado in the experiments being conducted at the Bureau of Mines oil-shale plant at Rulison, Colo., Director Turner of the Bureau of Mines has given recognition to the state in the appointment of Charles M. Bell, of Denver, as a consultant of the Bureau in connection with that work. He will make periodic trips to the plant and mine at Rulison.

Senator Shepperd is preparing several amendments to the potash act. He will ask that the law be changed so that land owners will be required to repay the expense of government prospecting only if their royalties from the sale of any potash discovered should be sufficient to justify it. He also hopes to liberalize the law so that drilling may be permitted under certain conditions if one owner of an extensive tract should agree to reimburse the government from any royalties that might accrue.

Placer Mining in Alaska on Upward Trend

The U. S. Geological Survey, in a preliminary report, says:

In spite of the fact that in many parts of Alaska placer mining was badly hampered by the shortage of rain during the first half of the open season of 1926, the production of placer gold showed a marked increase. The most noteworthy increases were reported from Seward Peninsula, the Fairbanks district, and the districts in the upper part of the Yukon basin. The increase in placer production is attributable principally to the increased production by the dredges, and about 60 per cent of the placer gold produced in 1926 was won by this method of mining. Twenty-nine dredges were in operation in 1926 and produced gold valued at about $2,200,000, which is somewhat more than $500,000 in excess of the amount that was recovered by this means in 1925. Among the new dredges built and operated during the year, the Nome Creek dredge, in the Fairbanks district, was the largest. Several dredges completed late in the preceding year did not begin to be really productive until 1926. Few projects for building new dredges took definite form during the year, though it is understood that plans are well under way for the installation of a dredge on American Creek, in the Hot Springs district, and that considerable prospecting for this enterprise was done during the season.

The Fairbanks Exploration Co. continued to develop its extensive properties on Goldstream Creek and in other parts of the Fairbanks district. Work on this property was carried on throughout the season and consisted mainly in building part of the long ditch from Chatanika River, near the mouth of Fairbanks Creek. It is understood that about 17 miles of this ditch is now completed, together with some of the necessary siphons. Though much other development work was in progress by this company, the property will probably not begin productive mining on a large scale before 1928.

Although placer mining by other methods than dredging was hampered in some of the districts by lack of water until after the middle of the summer, the camps in the Forty Mile, Circle, and Eagle districts, in the upper part of the Yukon basin, report that on the whole they had more and better distributed water than usual. This condition is reflected by the increase in the amount of gold they produced.

There is still a dearth of active and intelligent prospecting in many favorable placer localities. This is due in part to the large amount of money required for an adequate outfit, because many of the remaining places worth investigating present increasingly difficult mining problems, but it is undoubtedly also due to the fact that large quick returns no longer afford an incentive to the prospector. On the other hand, the more intensive type of prospecting now done by the larger companies and the consolidation and operation of larger units make for more intelligent management and lowering of costs and are in themselves a guaranty of continued profitable placer production.

Kootenay Florence Plans Long Tunnel

Kootenay Florence Mines has been formed to take over and develop the Florence mine, at Ainsworth, B. C. A. G. Larson, of Spokane, is president of and consulting engineer for the company. A 3,250-ft. tunnel will be driven from a point near the mill to open the orebody at a depth of about 400 ft. below the present lowest working. The Florence contains both fissure and replacement veins carrying silver-lead ore, the silver content of which usually has been lower than in most of the veins in West Kootenay.

Bonus for Mine Employees

ANNOUNCEMENT was made recently at Spokane that a sliding scale of bonuses would be paid to the 4,000 employees of Trail smelter instead of the flat bonus given to employees at this time in years past. The married employees who had been in the employ of the company since Jan. 1, 1926, were given $50. Those married who had been with company since July 1, 1926, received $25. Single employees since Jan. 1, 1926, were given $25, and single ones with the company since July 1, 1926, $12.50.

Profit From Waste Dumps, Joplin-Miami District

A net profit of more than $100,000 in three years from an original $4,000 investment is reported from the Joplin-Miami district, where the Clark Concentrating Co. has just closed another successful year of operation of its small mill at the Eagle-Picher Lead Co.'s smelter at Joplin. R. M. Clark, of Joplin, and Amos Hatten, of Webb City, both experienced mine operators in the Joplin district, are principal owners of the Clark Concentrating Co. Believing there were good lead values in a refuse pile at the smelter, they secured a 15 per cent ten-year lease three years ago, and erected a recovery plant that cost just $4,000.

The first year the price of lead was high, and double shifts were run. Next year lead prices eased off, and operations were reduced to single shift and that plan was followed in 1926. A check of profits was made recently, and Mr. Clark reports the company will pay an income tax on net profits of more than $100,000 in the three years. And the lease has seven years more to run. The Clark company recently sold its tailing mill on the Staton land at Cardin, Okla., to Archie Butler, trustee, for around $55,000. The new owner will put in a tube mill and flotation plant and otherwise improve the property.

Colorado Mining Men Oppose National Park Extension

Metal mining men of Boulder County, Colo., have again taken up the fight to prevent the extension of the boundaries of Rocky Mountain National Park to include Arapaho peaks and other mineral-bearing ground in that area. They have announced their intention to oppose the proposed bill in Congress to revise the park limits, and have the active support of the farmers under the affected watershed and of northern Colorado interests concerned with hydro-electric power development. The opposition in all cases is based on the belief and claim that if the region were placed under the jurisdiction of the National Park Service it would become virtually impossible to file mining, water, or power claims in the future. About 60,000 acres is the amount it is proposed to add to the park.

Safety Award for Federal Mining & Smelting Employees

What is believed to be a world record in safe mine operation has been made by the Muncie mine of the Federal Mining & Smelting Co., located in the south part of the Oklahoma section of the Joplin-Miami zinc and lead district. On Dec. 15, 1926, this mine had operated since July 23, 1925, without a single lost-time accident. This is a total of 37,785 man-shifts. The average number of men employed at the property in this time has been 80.

P. W. George is general superintendent for the Federal company in the Joplin-Miami district, T. W. McNeely is safety engineer, and D. Downing is ground foreman at the Muncie.

The mine naturally won the first prize in the safety contest in the Joplin-Miami district in 1926.

Safety flag and cup awarded to Muncie mine employees

Michigan Iron Mines Have Large Stockpiles

Many of the mines in Michigan are carrying over large stocks of ore this winter, showing a supply greater than demand. The Cleveland-Cliffs Iron Co. has turned its four hydro-electric and two steam plants over to a new company, the Cliffs Power Co. This latter has a utility franchise and is to supply current for some of the mines of other operators. Very little diamond drilling is being done at present, the Ford Motor Co. being the only operator with several drills in service. The Hiawatha mine, of the M. A. Hanna Co., on the Menominee range, is to have a new steel headframe and new electric surface equipment. This work will be started early in 1927.

Lightning Creek Gold Sues Government

Suit for $10,000,000 damages against the United States Government was filed in the Supreme Court of British Columbia Dec. 31, by the Lightning Creek Gold Gravel & Drainage Co. This amount is asked for alleged damaging statements concerning the company made by J. S. Swenson, of Seattle, a postal inspector.

Charles H. Unverzagt, associated with the company, is under indictment in Buffalo, N. Y., charged with using the United States mails to defraud in the sale of stock in mining enterprizes in British Columbia and Alaska.

Nome Ships 89,000 Oz. Gold—Tin Production Eleven Tons

Gold shipments from Nome, Alaska, to the United States Assay Office at Seattle amounted to 89,036 oz., valued at $1,616,663, in that part of 1926 to Oct. 31. Shipments of tin from Alaska amounted to 22,700 lb.

The Riverside mine, seven miles from Hyder, has undergone extensive prospecting under the new ownership. A vein has been discovered, of a width of 5 ft., carrying 18 to 20 in. of steel galena. The Kassan Gold Co. announces that its mine at Hollis, Prince of Wales Island, will be producing by March next. It is expected the mill will start on 50 to 80 tons of ore a day, with the intention of reaching 300 tons.

Fairbanks Exploration Co. has had 900 tons of pipe delivered for transportation to the scene of its extensive development operations at Fairbanks. The Chandlar mining district produced gold to the value of around $500,000, but is heavily handicapped by cost of transportation, which absorbs 50 per cent of the production. An effort is being made to have the Alaska Road Commission give some attention to a road construction policy for this part of Alaska.

Belmont Copper Completes Title to Consolidated Holdings

A transfer of mining property involving a payment of approximately $140,000 in cash was recently completed with the acquisition by the Belmont Copper Co. of complete title to properties taken over under option two years ago. The payment represents the balance due on the purchase price of $200,000, offered by the Belmont company to the Consolidated Holding & Trust Co. two years ago.

The properties are at Superior, Ariz., where the company is operating. Acquisition gives the Belmont a large, compact group of 120 claims, or approximately 2,400 acres. The holdings were originally taken over by the North Butte Mining Co., which later assigned them to the Belmont company.

Sinking of the main shaft has reached the 1,650 level, where a flow of hot water, highly mineralized, similar to that found in the lower levels of the Magma Copper Co., was encountered. The company has decided to start drifting under the ore from the 1,450 level, where a station had previously been cut. This is 300 ft. below the present workings. When sinking of the shaft is continued, it is probable that the shaft will be sunk to the 1,750 level, so as to give approximately 300-ft. lifts between the levels. Alexander MacKay is president of the company and Chester Hoatson, vice-president.

Wolf Tongue Developing Three New Veins

Two years of development work in the Cold Spring mine of the Wolf Tongue Mining Co., Nederland, Boulder County, Colo., has opened up tungsten ore along three veins, which insures constant production during 1927, according to William Loach, manager. Twenty men are employed in the mine. Only development work has been done during the last two years, as enough ore was obtained from leasers and by purchase to keep the mill supplied. The mill will be started April 1, which is an earlier date than for several years past.

Applications for Mining Concessions in Mexico Decrease

Applications for mining concessions in Mexico have fallen off heavily since the promulgation of the recent law on mineral industries, the U. S. Commerce Department is advised. During August and September, 1926, only 46 applications were received by the Mexican Department of Mines, compared with 522 during the corresponding months of 1925, when the old mining law was in force.

Toronto Letter

By Our Special Correspondent for Northern Ontario

Ontario Gold Production Shows Increase—Dividends Larger—Crown Reserve Sold

The dividends of the gold and silver mines for 1926 indicate the growth and prosperity of the mining industry in northern Ontario. They represent a substantial increase over the record for 1925 and amount to a total of $11,599,745. Of this amount $7,516,268 was paid by three Porcupine mines; $2,368,464 by three Kirkland Lake mines, and $1,715,012 by four silver mines. The disbursements of the silver companies represent a decrease of $172,000, but the disbursements of the Porcupine mines show an increase of $433,000, and Kirkland Lake shows an increase of $1,218,000. These dividends do not include substantial disbursements by the International and Mond Nickel companies, in the Sudbury district.

The Ontario Bureau of Mines report of the gold production for November shows that 323,452 tons was treated, the recovery being $2,553,308, an average of $7.90 a ton. This represents an increase of $217,000 as compared with the previous month. Porcupine mines treated 272,121 tons and recovered $1,909,735, an average of $7.04 a ton. Kirkland mines treated 51,331 tons and recovered $643,573, an average of $12.55 a ton.

During the first eleven months of the year total production amounted to $28,500,139, an increase of $1,300,000 over that for the corresponding period of 1925. The average recovery for the first eleven months was $8.47, as compared with an average recovery of $8.88 for the first eleven months of 1925.

Stock Markets Active

The feverish activity in Quebec stocks is continuing, and many new high prices have been registered. There is either a very strong and widespread belief in electrical prospecting, or people are seized with an irresistable desire to gamble. Area, which was 30c. within the last two weeks, sold up to $1.40, and Amulet, which adjoins the Area, went from $1.50 to $2.90 in the same period. Several of the "cats" are also getting a ride, because no one knows what may happen in Quebec if the ore indicated on Area and Amulet is confirmed by the diamond drill. The drill is now on the Area ground, and information should be available in a few days. If high-grade copper ore is found, there are still possibilities for an advance of several hundred per cent in these stocks.

Sale of Crown Reserve

The directors of the Crown Reserve Mine, Larder Lake, have closed a transaction for the sale of the property at a price of $210,000, less a commission of 10 per cent. It is understood that $10,000 has been deposited to bind the bargain. A special general meeting of the shareholders will be held on Jan. 12, to consider the matter, and, if it is approved, to ratify it. The Crown Reserve property has developed a considerable tonnage of low-grade ore, but a large amount of money still remains to be spent to determine whether or not there is a sufficient tonnage to justify a mill. A good deal of the ore occurs close to a graphitic fault and the treatment of the ore presents some metallurgical difficulties. It is believed, however, that by the addition of crude oil a satisfactory recovery can be obtained. If the negotiations for the property go through it is believed that the directors will utilize the funds to explore the company's holdings in Quebec. The company has substantial holdings in the Lake Fortune area just west of Rouyn. Only a small amount of surface exploration has been done, but some encouraging indications have been found.

Quebec Prospectors Listed

It has been decided to list the shares of the Quebec Prospectors, Ltd. This company was formed in 1923 by a small group of men, a number of whom were employees of the Ontario Mines Branch. Employees of the Mines Branch are now allowed to deal in Ontario mining stocks or hold Ontario mining claims, and it was decided to form a small exploration company to look for properties in Quebec. The company has a capital of 1,000 shares of $50 par value, and since 1923 has been sending out prospecting parties. The work has been done very cheaply, as prospectors were given comparatively small wages and a substantial interest in anything they found. There has been no overhead expense, and the direction of the prospectors has been in very competent hands. A number of properties were staked in Quebec, one of which was optioned to the Dome, but the option was not exercised. Last September, however, claims were staked on behalf of the Quebec Prospectors by J. M. Robb, in Mountbray Township, and were optioned to the Nipissing. This is the principle Nipissing holding in Quebec, and good discoveries have been made on it. The shares, which have a par value of $50, are at present quoted from $270 to $300, but nobody seems very anxious to sell.

Power Expansion Under Way

The Canada Northern Power Corporation, which supplies power to all the mining camps of northern Ontario, has made plans for the linking up of the various systems in northern Ontario and Quebec. Recently a line was completed into Rouyn from the Quinze power plant in Quebec and a branch is being run to the Alderson-McKay property. It has been decided to continue this line to Kirkland Lake, and frequency changers will be installed in that camp, as the Quebec power is 25 cycle and the power at present being used in Kirkland is 60 cycle. The company apparently has substantial faith in the mining industry of northern Ontario and Quebec and is preparing to spend large sums of money to insure an uninterrupted supply of power to all the camps. To provide additional storage for the Indian Chutes plant on the Montreal River, a new storage dam will be built at a cost of $170,000.

London Letter

By W. A. Doman

Special Correspondent

Metal Prices Steady—Tin to Remain High—German Zinc Syndicate Dissolved

London, Dec. 21—While prices of metals remain fairly steady, relatively little business is being transacted in them. The market seems to have taken on a "Christmassy" appearance, and, improved trade conditions notwithstanding, inquiries are not expanding. Lead is the doubtful item at the moment. As regards tin, everyone is more than hopeful; so much so, in fact, that a price exceeding £300 per ton is predicted for the next few years. This view is enabling directors of producing companies to divide profits rather more liberally among shareholders, so that, generally speaking, shares are well held. Malayans continue the favorites, as against Nigerians, as working expenses in the East are less burdensome than in Africa. As I have before mentioned, however, in some respects an unhealthy position has been created by the flotation of properties with poor prospects, simply to make market paper. In one or two cases, too, directors have asked for substantial rewards for services that should come within their ordinary duties. To mention names would be impolitic.

The German Zinc Syndicate will come to an end on Dec. 31. The early dissolution is due to the action of the Silesian members who have been in favor of granting extended credits to Russia. The other members do not favor the proposal, possibly because they doubt the *bona fides* of the Soviet purchasers. The Russian trade associations, which are really the Russian Government, declare that they have never defaulted in their engagements, but many people have had an unpleasant experience in connection with the chervonetz notes. These were allowed to go abroad, and then when attempts were made to cash or repatriate them they were virtually repudiated. Such action does not make for confidence, and is certainly a bear point in England.

The Malayan Tin Dredging was so successful in various ways during its year ended on June 30, and subsequently, that the directors have repaid the second loan of £150,000 granted under the Trade Facilities Act for the purpose of equipping one of the properties with plant and machinery. The indebtedness to the government now stands at £100,000, this being the amount of the first loan.

Following on my brief reference to the Mawchi Mines a fortnight ago, it is worth mentioning that at the annual meeting the chairman stated that the reduced output might ultimately be accounted for partly by the fact that some of the mill plant, particularly the concentrating tables, was found, after a comparatively short time of working, to have again become inefficient and beyond further repair. New tables were ordered, but were delayed by the

coal strike in England and the heavy rains in Burmah. Transport had also proved difficult, as the mine had been closed down for five years.

The extraction of gold at the Chosen Syndicate property in Korea has improved, and E. T. McCarthy, the consulting engineer, looks for a recovery of 88 to 90 per cent to be reached in due course. The ore reserves are nearly three years ahead of the mill, being 195,891 tons, assaying 8.96 dwt., thus placing the operations on a sound basis as regards the immediate future.

Diamond Syndicate Strengthened

Control of the Diamond Syndicate has been strengthened by establishment of friendly relations with Belgian Angola producers to limit output, according to S. B. Joel. Contracts have been arranged for five years, he declared, to purchase the output of British Guiana and West African Selection Trust. Referring to competition from alluvial diggers, he said it was only reasonable that these producers should share with others the burden of maintaining prices of diamonds by limitation of output, which determines the prosperity of the industry. The company will approach Premier Hertzog on his return from South Africa to bring alluvial production under control. In the meantime, however, the syndicate is purchasing the bulk of alluvial production so as to protect the industry.

Oil Mining vs. Drilling

According to a report made by Colonel R. B. Harkness, Natural Gas Commissioner for Ontario, to the Provincial Department of Mines, the value of the southwestern oil fields of the province could be increased by several millions of dollars by the substitution of a system of oil mining for the present method of oil extraction. The pumping method recovers not more than 10 to 20 per cent of the petroleum in a given field, whereas it is estimated that the oil-mining method will recover at least 80 per cent of the remainder.

In the course of his report Colonel Harkness estimated that from the Enniskillen and the Petrolia fields a maximum further recovery of 25,040,000 bbls., or a minimum of 12,072,560 bbls., should be possible; from the Oil Spring fields a maximum of 12,265,000 bbls. and a minimum of 5,290,000 bbls.; and from the Bothwell fields a maximum of 6,393,000 bbls. or a minimum of 2,157,242 bbls. The cost of mining of the oil would be considerable, but where the conditions are suitable the process would yield a substantial profit.

Mining for oil is something new in Ontario, but Colonel Harkness believes it to be applicable to some if not all of the oil fields in the southwestern area of the province. The present process of pumping petroleum from the drilled wells leaves a large proportion of the oil unextracted in the body of the rock in which it occurs. Mining for oil consists of sinking shafts in the rock and driving galleries from these either above or below the oil-bearing strata.

The World's Largest Mercury Deposit

The largest and richest deposit of mercury now known in the world is at Almaden, in central Spain, near the extreme western point of the Province of Ciudad Real, states the Bureau of Mines, in the statistical report on "Mercury in 1925." This deposit has been mined almost continuously since Roman times and has been owned and worked by the Spanish Government since 1645. The orebodies are large, some of them attaining 36 ft. in width and as much as 600 ft. in length. The mine has been developed to a depth of more than 2,000 ft. and the available reserve has been estimated as at least 40,000 metric tons of metal.

In the lower workings the oreshoots are longer, the tenor of the ore is higher, and the vein is wider. The average content of all ore mined is said to be about 8 per cent. According to Spanish Government reports, however, the mercury extracted was 6.06 per cent in 1922. Production in the last two years has amounted to about 26,000 flasks per annum. In 1924 the productivity per man was 18.53 flasks. The pre-war average cost of producing a flask has been estimated at $15; since the war the working costs have been estimated at $45 per flask. Deposits of minor importance are found in the provinces of Asturias, Badajos, Granada, Santander, and Valencia.

California Oil Production Exceeds 660,000 Bbl. Per Day

THE American Petroleum Institute estimates the daily average crude oil production in California for week ended Dec. 25, 1926, as follows:

	Barrels
Long Beach	94,500
Santa Fe Springs	44,500
Huntington Beach	102,000
Torrance	26,000
Dominguez	19,000
Rosecrans	13,500
Inglewood	39,500
Ventura Avenue	50,800
Seal Beach	10,800
Midway-Sunset	91,000
All others	172,000
Total	663,600

Development Work in Progress at Beardmore

Diamond drilling and surface explorations are being steadily conducted on several of the best-known prospects at Beardmore, Ont., despite heavy snowfalls and cold weather, which have somewhat hampered operations.

The Beardmore Mines, Ltd, with headquarters in Toronto, is apparently well satisfied with the results of the previous shaft-sinking and diamond-drill work carried out in the last few months on the original "discovery" claim, having now set apart $50,000 for further development work, which will include considerable drilling to be done under contract by the Sterling Diamond Drill Co.

The company during October drilled about 1,100 ft. from two set-ups, and general progress is at the rate of 200 ft. per week. Five holes have been drilled at a 45 deg. angle toward the north to approximately a depth of 450 ft. each. The hole at present being drilled will cut the main vein at a point considerably east of the previous drillings, and is to be put down to a depth of about 500 ft. Operations under way will determine the tonnage available for mining above a depth of 300 ft.

Just previous to the setting in of winter a number of promising veins were uncovered south of Jackpine, a railway station 5 miles east of Beardmore. This occurrence, in its central portion, is paralleled by other but smaller gold-bearing veins. The Jarvala vein, on the Jarvala property, a short distance west of Jackpine, contains spectacular showings of free gold at points along the wallrock.

Copper King Resumes

The Copper King Mining & Smelting Co. will resume operations on the completion of timbering in the lower tunnel, according to reports received at Spokane, Wash., from Mullan, Idaho, near where the mine is located. The retimbering has proceeded for 6,000 ft. of the 7,000 ft. which the tunnel has been driven. Many caves, some of them large, have been caught up.

Grand Central Mining Co. Reports Progress

The annual statement recently sent out to stockholders of the Grand Central Mining Co., operating lead-silver properties at Aravaipa, Ariz., reports that since this property was taken over, in October, 1925, a total development footage in shafts, drifts, winzes, and raises, of approximately 1,774 ft., has been driven, with a total developed tonnage of 55,000 tons of oxidized ore, carrying an average value of 15 per cent lead. Approximately 1,800 tons of ore was mined and shipped up to Aug. 31, 1926.

A mill with a crushing and grinding capacity of 150 tons daily and a flotation capacity of 90 tons daily has been constructed. It is planned to start the mill with an initial daily run of 30 tons, increasing the tonnage as rapidly as results justify. The difficulty of transportation costs will be greatly simplified with the operation of the mill, as a favorable contract for freighting concentrates at a cost of $7 per ton has been made by the company. Lewis W. Douglas is president and Harry Hendrickson is in charge of operations at the mine.

United Algoma Busy on Development Work

United Algoma Mines, Ltd., has for some time been developing the Grace and Star properties, in the Michipicoten gold area of Ontario. Channel assays on a large vein which has been opened up for 1,800 ft. show good values in gold. The mine has been electrified. An additional 1,100 cu.ft. compressor is now being installed and the shaft will be put down from the 300 to the 500 level, and extensive lateral work will be carried on during the winter.

Johannesburg Letter

By John Watson
Special Correspondent

South African Mineral Production Shows Large Increase in 1926

Johannesburg, Nov. 30—The Union Department of Mines issued an abstract, on Nov. 27, showing the output of minerals up to the end of October, as follows:

Ten Months' Production	Jan. to Oct. 1926	Jan. to Oct. 1925
Gold	£35,184,595	£34,089,331
Silver	108,031	144,952
Osmiridium	84,353	143,814
Platinum	64,168	.....
Diamonds	8,640,694	6,805,277
Coal	3,310,737	3,235,736
Copper	376,450	438,133
Tin	267,072	219,920
Other minerals	271,873	231,622
Totals	£48,307,973	£45,308,785

As the above figures show, the principal increase is in diamonds, the value of which output for the last ten months is £1,835,417 more than in the corresponding period of 1925. The gold output shows an increase of £1,095,264. "Other minerals" show an increase of £40,000. The principal items in this class are asbestos, corundum, and iron ore.

A famous South African diamond, found in 1913 on the Vaal River, at Sydney-on-Vaal, was offered for sale at Christie's, London, recently. This stone is of an amber or resin color and weighs 61½ carats. It was formerly known as the "Tiger's Eye," but recently has been named the "Golden Dawn." Its value is said to be about £30,000; but its owner, Captain Lucas, has offered to give any proceeds over £25,000 to Lord Haig's fund for ex-service men.

Waaikraal gold mining shares have been booming recently. This Waaikraal is the Farm No. 205, 25 miles northeast of Rustenburg, to which reference was made in my letter of Sept. 7. The Pretoria correspondent of *The Star* recently described the discovery. On Waaikraal is a fine big house built by the Rev. Behrens, aged 67, a missionary there as his father was before him. His old friend, Moorcroft Edwards, visited the scene, and, after searching for platinum, the Rev. Behrens took Edwards to a spot and said, with spade in hand, here you must begin. A start was made and the gold reef was found. Mr. Behrens had just signed a contract, selling the farm and house to the Edwards syndicate for £16,000, when an offer came of £50,000 from one of the "big houses" in Johannesburg.

The annual meeting of Sub-Nigel, Ltd., was held on Nov. 26, at the Consolidated Gold Fields Building in Johannesburg. Douglas Christopherson, the chairman of the board, described the operations of the last year in an exhaustive review. Future prospects are encouraging; but caution is advised. As a London financial paper says, the question of persistence in depth of the rich gold shoots is "in the lap of the gods."

On the Johannesburg Stock Exchange during the last week there has been a large increase in the volume of business, mainly due to London orders. Sub-Nigels were largely bought for London and their price has improved during the week from 62s. 3d. to 63s. 9d. Waaikraals were largely dealt in and fluctuated freely. Their price has fallen, however, from 85s. to 63s. Doornhoek Platinums have improved, owing to their tin deposits, from 2s. to 3s. T. C. Lands have improved from 44s. to 47s. 3d.; and P.p. rust platinums remain at about 8s.

Baker County, Oregon, Has Placer Possibilities

The mining resources of Baker County, Oregon, are undeveloped for want of capital, although there has been a great deal of activity in prospecting and developing the last two years. There are several properties that have merit, both in quartz and placer, and some dredging possibilities that would enable several dredges to operate for a number of years. Development probably will be carried on next summer on a number of properties that changed hands during the last year.

W. J. Gear is equiping a placer property with two hydraulic giants to handle at least ten thousand yards every twenty-four hours. The gold is usually coarse, and the gravel also contains values in platinum.

Sunnyside Shaft Sinking Nine Feet Per Day

J. L. McIver, general superintendent of the Sunnyside Mining Co., Oatman, Ariz., states that good progress is being made in sinking the company's two-compartment shaft. Contractor Jack Harrington is employing three shifts on the work and has sunk to a depth of 180 ft. in twenty-one days, or at the rate of 9 ft. daily. This is thought to be a record for the district. The former record was made in the sinking of the No. 3 shaft of the United Eastern, which was sunk to 800-ft. level at the rate of 5 ft. per day. The shaft is being well timbered and lagged, and when completed will serve the company as a permanent operating shaft.

Waite-Montgomery May Be First Rouyn Shipper

The Waite-Montgomery, in the Rouyn area of Quebec, is likely to be one of the earliest producers in that field. Plans for development as announced by N. A. Timmins involve the removal of 30 or 40 ft. of the overburden from the main orebody by steam shovel. Ore will be shipped to the Horne smelter, when the latter is completed. Though stating that all the properties with which he is connected would ultimately come to concentration and separation, Mr. Timmins says that considerable ore is available for treatment in the meantime.

Societies, Addresses, and Reports

National Slate Association Will Hold Annual Meeting Jan. 18

The annual meeting of the National Slate Association will be held at the Commodore Hotel, New York City, Jan. 18 and 19, 1927. Group meetings of the various branches of the industry will be held on the second day. The conferences will close with a joint session of Slate Roofing Contractors and the United Roofing Contractors Association.

A New Italian Petroleum Institute

The opinion that the recently formed "General Italian Petroleum Control Institution" (Azienda Generale Italiana Petroli) had for one of its purposes a monopoly of mineral oils in Italy is entirely erroneous, according to Senator Conti, the president of the institution. In a report from John Ball Osborne, U. S. Consul at Genoa, made public by the Department of Commerce, Senator Conti's reply to this intimation of monopoly is set forth.

The "A.G.I.P." will not in any way hinder or interfere with private industry, Senator Conti states. Its task is essentially to organize and discipline. It is Italy's intention to work amicably with the foreign petroleum trusts, her sole aim being to work in the interests of the country. Any idea of speculation is excluded from the program of the "A.G.I.P." It will be sufficient that the capital invested shall receive adequate remuneration in accordance with the current average rate of interest.

Leipzig Fair Dates Announced

The Leipzig Trade Fair, representing every phase of the industrial life of Germany, will be held from March 6 to 12, 1927. The fair makes it possible to measure definitely the recent progress of German industries. It will include more than 12,000 exhibits, a gain of over 300 per cent over any prewar fair.

South African Engineers Meet at Johannesburg

The Association of Certificated Mechanical and Electrical Engineers, of South Africa, held a banquet at the Langham Hotel, Johannesburg, on Nov. 19. Arthur French, president of the Chamber of Mines, said the mining industry had carried this country on its back for thirty-five years. Dr. J. H. van der Byl, responding to the toast of "South African Industries," said it was estimated that there was sufficient coal in South Africa to produce 200,000 million gallons of oil, which at the present rate of consumption was sufficient to supply South Africa for 1,000 years.

People You Should Know About

William Spence Black, of Boston, was in New York last week.

H. R. Robbins has returned to Japan in the interests of the American Cyanamid Co.

F. R. Koeberlin, of Santiago, Chile, is at the Hotel Commodore, New York He will return to Chile about March 15.

L. C. Shattuck, president of the Shattuck-Denn Mining Corporation, of Bisbee, Ariz., was recently married to Miss Mary O. Wilson, of Douglas.

Colonel Henry H. Armstead has returned to Washington, D. C., from a trip to his mining properties in British Columbia, and will be in New York in January.

H. J. Brown, consulting engineer of West Newton, Mass., has just returned from an extensive trip to some of the larger gypsum deposits of Nova Scotia and Cape Breton.

G. A. Joslin, who had been in South America for the last year for the American Metal Co., has returned to the United States and will spend a few weeks in Los Angeles.

W. Earl Greenough, mine owner of the Coeur d'Alene district, in Idaho, has been in Chicago and New York in connection with various properties in which he is interested.

Charles Spearman, consulting mining engineer, of Montreal, has just completed an examination of the Night Hawk Peninsula mines, in the Porcupine district, for Philadelphia interests.

James Dickson has been appointed chief inspector of mines for British Columbia, in the place of the late George Wilkinson. Mr. Dickson has been acting chief inspector since Mr. Wilkinson's death.

C. S. McLean, general manager of the West Rand Consolidated G. M. for the last three and a half years, is leaving the Rand, with Mrs. McLean, on a six months' holiday trip to England and Canada.

R. S. G. Stokes, assistant general manager of the De Beers Consolidated Mines, Ltd., accompanied by Mrs. Stokes and two daughters, returned to South Africa from a visit to England. on Nov. 20, last.

H. C. Carlisle, of San Francisco, in charge of western operations for the Tonopah Mining Co. of Nevada, has returned to San Francisco after completing mine-examination work in Utah and western Nevada.

W. J. Hamilton, mining engineer, who was for many years in charge of the Guggenheim operations and is now connected with the Cerro de Pasco Copper Co., is directing work on the Don Rouyn mine, in the Rouyn area of Quebec.

Clarence R. King, who for the last three years had been acting as metallurgist for the California Rand Silver Co., Inc., at Randsburg, Calif., has severed his connection with the above-named company and has gone to Hinkley, Calif.

James MacNaughton, general manager of Calumet & Hecla Consolidated at Calumet, Mich., who has been elected president of the company to succeed R. L. Agassiz, voluntarily retiring from that position, will continue his residence at Calumet and supervision over the properties. Mr. MacNaughton was the vice-president. He has been

James MacNaughton

general manager of Calumet & Hecla since 1900, having been appointed by the late Alexander Agassiz, father of the retiring president. Previously, he was engaged in the iron-mining industry on the Menominee range in Michigan. Under his supervision, Calumet & Hecla has prospered and expanded and retained its status as one of the world's largest copper producers. Mr. MacNaughton is a graduate mining engineer. He has spent nearly all of his life in the Michigan copper district, having received his early education in the Calumet public schools.

R. A. Hardy, of Virginia City, Nev., has been appointed receiver for the Ramsey Comstock mine, in northern Nevada, and **Roy K. Brown**, for several years mine superintendent for the Tonopah Belmont Development Co. at Tonopah, Nev., has been placed in charge of operations at the mine.

T. P. Lane has been appointed superintendent of the Lucky Jim mine and has left for the property at Zincton, B. C. Mr. Lane had been superintendent of the Saltchuck, a palladium mine owned by A. Chilberg, of Seattle, for the last three years, and before that was assistant superintendent of the Kennecott Copper Corporation properties in Alaska.

L. S. Cates, vice-president and general manager of the Utah Copper Co., spent the holidays on the coast, where at San Francisco, he married Mrs. Eleanor Christenson, widow of a wealthy shipowner, the first of the year. After the wedding Mr. and Mrs. Cates returned to Salt Lake City, where it is expected they will make their home.

Obituary

Peter W. Breen, a pioneer mining man of Colorado, and formerly a Lieutenant Governor and Treasurer of that state, died in Leadville on Dec. 25, 1926. Mr. Breen won a fortune from the Colonel Sellers mine, at Kokomo, and always maintained an active interest in Colorado mining. He is survived by Peter W. Breen, Jr., a cadet at West Point.

C. F. Brooker, chairman of the board of directors of the American Brass Co., died at Daytona Beach, Fla., on Dec. 20. Mr. Brooker was seventy-nine years old. He is reported to have bought more copper than any other man in industry; and he also took a marked personal interest in the civic and political affairs of Connecticut, his native state.

William Arthur Caldecott died suddenly at his farm, Selborne, in Sundays River Valley, near Nitenhage, Cape Colony, South Africa, on Nov. 26, 1926. Born at Malta in 1869, he was the only son of the Rev. W. S. Caldecott, the grandson of an 1820 settler. He was educated at Grahamstown and the South African College, Capetown. He came to the Transvaal in 1889 and worked one of the first cyanide plants (MacArthur, Forrest process) in the Barberton district. Later, he was on the staff of Charles Butters, at the Rand Central Ore Reduction Works. For many years after the South African War Dr. Caldecott was consulting metallurgist to the Consolidated Gold Fields, Ltd. A few years ago he was appointed scientific and technical adviser to the Industries Division and editor of the *Industrial Journal of the Union*. From 1904 to 1905 he was president of the Chemical, Metallurgical and Mining Society. In 1899 he married the eldest daughter or the late William Hume. Dr. Caldecott is survived by his widow and by two daughters.

Alexander D. Moffat, for fifty years engaged in Utah mining, and father of D. D. Moffat, assistant general manager of the Utah Copper Co., died on Dec. 27 at his Salt Lake home at the age of seventy-five years. Mr. Moffat was born in Edinburgh, Scotland. He gained his first experience as a miner at Alta during the 70's, then at the height of its prosperity. From Alta he went to Park City. Mr. Moffat became associated with the Ontario Mines Co., the first to open a bonanza orebody in that region. In 1886 he was made mill superintendent for that company. Then he was sent to Mexico by the Hearst-Haggin interests. Later he was employed for a time by the Granite Bi-metallic Consolidated Mining Co. of Phillipsburg, Mont. Altogether, he was in Park City for thirty years. After leaving Park City Mr. Moffat went to Newhouse as general superintendent of the Newhouse Mining Co. Later he went to the Majestic Mines Co. at Milford as general manager. He was associated with this company up until the time of his death. Mr. Moffat is survived by his widow and by two sons and a daughter.

Recent Technical Publications

Reviews, Abstracts, and References

Immigration and Emigration

Migration and Business Cycles. A survey of the economic causes and effects of migration, with particular regard to the supply of labor in the United States. By Dr. Harry Jerome, of the National Bureau of Economic Research, New York. Price, $3.50.

To what extent are fluctuations in migration attributable to fluctuations in employment, and to what extent, in turn, are fluctuations in migration an ameliorating influence, or an aggravating factor, in employment and unemployment fluctuations? These two questions form the basis of a study of the relationship between industrial cycles and American immigration and emigration by Dr. Jerome. The facts indicate that both cyclical and seasonal movements are important in immigration and emigration, and abundant evidence is offered that when immigration is not restricted the character of the cyclical variation, at least, is closely similar to the cyclical variation in employment opportunity in the United States. A fairly close similarity is also found in the seasonal movements. The seasonal increase is in the spring, well timed for the summer increase in those outdoor activities in which many new immigrants ordinarily find employment; and the maximum emigration is reached in the late fall and early winter, when jobs are becoming relative'y scarce. Similarly, a period of depression in the United States is ordinarily accompanied or closely followed by a decline in immigration and an increase in emigration; and a period of prosperity, by an increase in immigration and a decline in emigration. The study shows that the movements of those immigrants who have no gainful occupation are decidedly less responsive than the movements of the working elements to cyclical and seasonal variations in employment.

Colonel M. C. Rorty takes exception to the conclusion reached in this study that a net immigration during periods of declining employment would, in itself, justify the conclusion that such immigration contributes to or accentuates unemployment. He points out that immigration might involve a gradual shifting of the native-born workers from unskilled to skilled or semi-skilled occupations, but such a process, if continuous and uniform, should not involve economic disturbances of serious character. The book is well worth reading by those interested in the subject of immigration and emigration in their relation to industrial occupations.

ROBERT M. DAVIS.

Tests for Laboratory Weights—No. 527 of the Scientific Papers of the U. S. Bureau of Standards, pp. 28, discusses "Short Tests for Sets of Laboratory Weights," by A. T. Pienkowsky. It may be obtained for 10c. from the Superintendent of Documents, Washington, D. C.

Flotation Testing—G. C. McLachlan amplifies his paper published in the *E. & M. J.-P.* of Sept. 12, 1925—"An Explanation of Flotation Based on X-Ray Data"—in a 30-page paper in the *Bulletin* of the Canadian Institute of Mining and Metallurgy, for September (Drummond Building, Montreal; price $1). This is entitled "Synthetic Testing for Flotation" and attempts to show that chemical affinity is the governing force in the flotation process.

Electrical Prospecting—In the bulletin mentioned in the preceding paragraph is also a 12-page paper by James I. Moore, Jr., and Frank Ebbutt, on "Electrical Prospecting at the Britannia Mine." Various methods are briefly described, but few conclusions are drawn from the work—at least, not in detail.

Rocks and Minerals—A new small quarterly magazine devoted to rocks, minerals, ores, crystals, and gems, in the interest of the general collecting public, made its first appearance with the September number. It contains an article on the identification of minerals, giving a list of the apparatus and reagents needed, which is to be continued in succeeding issues. The publisher is Peter Zodac, 157 Wells St., Peekskill, N. Y., who is also a dealer in minerals. It is planned to sell single copies of the little magazine for 20c. each, or 50c. a year in the United States and 75c. in foreign countries.

Federated Malay States—The Chief Secretary's Annual Report for 1925, Federated Malay States, is now available. Smuggling out of rubber seems to have caused the government as much trouble, comparatively, as the liquor business in the United States. The conduct of opium smoking dens is now a government monopoly and "entirely successful." Export of tin and tungsten ore is important, and the Raub gold mines, the only active producer, turned out about 12,000 oz. The report, which contains a colored map of Malaya, may be obtained from the Government Printing Office, Kuala Lumpur, Federated Malay States.

South Australia—Bulletin No. 12 of the Geological Survey of South Australia, Perth, by R. Lockhart Jack, is devoted to the clay and cement industry in that state.

December Patents

Gyratory Crusher — No. 1,609,594. Dec. 7, 1926. H. S. Anderson, Waterville, Ohio. Design for a gyratory crusher.

Electrolytic Refining—No. 1,609,771. Dec. 7, 1926. F. F. Poland, Baltimore, assignor to American Smelting & Refining Co., New York City. A method of spacing cathodes and anodes in the electrolytic refining of metals.

Tin Refining—No. 1,609,967. Dec. 7, 1926. Ludwig Schertel and Willi Lüty, Essen-on-the-Ruhr, Germany. In refining molten tin, elements are introduced the formation heat of which per unit of oxygen is greater than that of tin. The molten mass is then subjected to the action of an oxidizing agent and the impurities removed in the resulting scum.

Flotation Reagents — No. 1,610,217. Dec. 7, 1926. H. W. Elley, Wilmington, Del., assignor to E. I. du Pont de Nemours & Co., Wilmington. A flotation reagent having the following general molecular formula:

R—NH—CS—NH—R'

where R and R' represent unsubstituted aliphatic radicals.

No. 1,610,298. Dec. 14, 1926. C. P. Lewis, Burlinghame, Calif., assignor to Minerals Separation North American Corporation, New York City. A pulp of iron-bearing zinc ore is agitated with sufficient lime to make it alkaline, and with a sulphur-containing organic compound; it is then further agitated with a copper salt and with a mineral frothing agent, to produce a froth rich in zinc and poor in iron.

Flotation Cell—No. 1,612,625. Dec. 28, 1926. J. M. Ferguson, Provo, Utah. Design for a pneumatic flotation cell with an inclined air box over which porous mats are tautly stretched and clamped.

Gas Separation—No. 1,610,288. Dec. 14, 1926. E. M. Jones and G. E. Beavers, Copperhill, Tenn.; A. M. Fairlie, Atlanta, Ga.; and J. N. Houser, Knoxville, Tenn.; assignors to Tennessee Copper & Chemical Corp., New York City. A process of separating oxides of nitrogen and sulphur dioxide from other gases in a mixture, by absorption of the gases named in activated carbon.

Concentrating Table — No. 1,610,715. Dec. 14, 1926. A. H. Stebbins, Los Angeles. A riffled deck surface for a concentrating table.

Ore Conveyor—No. 1,610,752. Dec. 14, 1926. C. E. Davis, Chicago, assignor to Goodman Manufacturing Co., Chicago. A conveying apparatus, equipped with a scraper, for handling ore.

Gravity Concentrator—No. 1,611,339. Dec. 21, 1926. F. H. Cothay, Sussex, England, assignor of one-half to Ropp Tin Limited, London, E. C. 2, England. A stationary inclined concentrating sluice, equipped with riffles.

Fume Collector—No. 1,611,548. Dec. 21, 1926. John Miller, Douglas, Ariz. Design for a water-spray apparatus for precipitating the solid particles from smelter smoke.

Mining Sulphur—No. 1,612,453. Dec. 28, 1926. W. T. Lundy and H. S. Burns, Freeport, Tex., assignors to Freeport Sulphur Co., Freeport, Tex. Into the sulphur-bearing formation is injected a heated mixture of water and a finely divided earthy mineral, the mixture having a viscosity greater than that of water; and the fused sulphur recovered.

Smelting Furnace — No. 1,612,571 Dec. 28, 1926. H. L. Charles, Kent, Wash. Design for a reverberatory smelting furnace with a convexly shaped integral bank extending along each side and end wall, and also a longitudinal bank of inert material down the center of the furnace.

Rock Drill—Nos. 1,612,783-4. Dec. 28, 1926. E. G. Gartin, Claremont, N. H., assignor to Sullivan Machinery Co. Design of a rock-drilling mechanism.

New Machinery and Inventions

New Mounted Diamond Drill Developed for Deep Structure Testing

To meet the requirements of the deeper structure testing in oil-field exploration the Sullivan Machinery Co., of Chicago, Ill., has designed a new (Class N) portable and mounted diamond core drill. This is an entirely new machine and has been built to embody the experience of the past five years with diamond core drills in structure-finding work. The engineers of this company have followed the work of the older machine in the field with great care, and have combined their own experiences of more than a generation in the design and manufacture of diamond drills with the experience of the company's customers and of their geologists, to produce a diamond drill for structure work which is calculated to give the best possible prospecting results.

The experience referred to above has indicated the demand for a heavier and more powerful machine than the Type CN mounted drill, equipped with Fordson engine, which has been in use for several years past. Balance in power and strength is of utmost importance in diamond-drill design. Too much power at the engine will result in frequent breakage to the drill parts. On the other hand, insufficient power is a handicap and places the machine in a class with those of lower rating. For this reason the power unit differs with the capacity rating in all Sullivan drills. A careful study of all available engines led to the selection of the Buda model for this drill.

The "CN" machine has a capacity of 500 to 1,000 ft., removing a 2-in. core. The new Class N machine will remove a 2-in. core to a depth of 2,000 ft. with equal ease and rapidity.

Power and strength have been the dominant factors in designing the new mounted "N" drill. An entirely new hydraulic feed cylinder has been constructed. This cylinder provides an 18-in. feed or run of the drilling rod instead of 12-in. The drive rod is of heavy hexagonal section and will accommodate size PK rods, which are 2¾-in. in diameter and give a much greater circulation capacity for using mud in connection with fishtailing. The design of this hydraulic swivel head is a departure from that which has been standard for years in mineral prospecting. Use of large fishtail bits with mud calls for a more rugged and substantial construction. Large steel gears are provided, and the bearings are sealed against damage from mud fluid. The hydraulic cylinder of course is more powerful than that on the Type CN.

Eighteen-inch horizontal travel on the sliding rails or track is provided, giving ample room for hoisting large casing elevators, and other parts. An independent heavy-duty clutch is provided to throw out the drill while the engine and pump are running. The thrust head is ball bearing and is completely inclosed, running in grease and protected from mud. The swivel head has Alemite lubrication throughout. If necessary a "Kelley" may be used, with automatic chuck.

Power is transmitted from the engine to the drill through specially designed transmission gears and clutches. A large ball bearing immediately behind the engine clutch insures exact alignment. The forward movement of the drill is provided for by using a rifled telescope shaft, again eliminating splines and keyways.

The hoisting drum is of the Sullivan internal-gear type and is of ample strength and speed for handling the rods and also for driving stand pipe and setting casing. A cat-head is supplied to assist in working the drill in and out of locations and for use with a "cat-line."

For drilling and hoisting a heavy-duty transmission is connected to the engine through a twin dry plate clutch, inclosed in the engine housing, which has the same rigid construction as on motor trucks. The ability to run the drill at varying speeds is of great assistance in working through different types of ground.

Buda Engine Used

The power plant consists of a 30-hp., 4-cylinder, 4-cycle Buda engine, famous for its efficiency, stability, and power. This engine is equipped with governor, air filter, vacuum tank, and radiator of ample capacity for continuous running. The fuel tank is set low on the side of the frame and may be filled by a man standing on the ground or by suction from the Stewart vacuum tank, from a barrel. The pump is a Gardner 3 x 4-in. duplex inclosed type with independent clutch and chain drive from a special power take-off on the transmission. This pump gives ample capacity for rapid operation of the hydraulic cylinder and can be used for circulating through the hole in case of emergency. Under ordinary circumstances a circulating pump operated by a separate gasoline engine is employed, but is not included with the drill outfit.

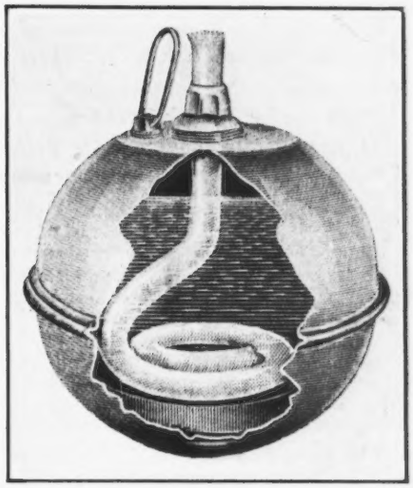
Net weight of "N" outfit less equipment, pounds	9,200
Length over all	12 ft. 8 in.
Width over all	4 ft. 10 in.
Wheel base	10 ft. 2 in.
Track gage	4 ft. 8 in.
Front wheels diameter 30 in., tread 8 in.	
Rear wheels diameter 38 in., tread 10 in.	
Buda gasoline engine, 30 hp.	
Fuel tank 12-in. diameter, 25-in. length.	

The frame or truck base is made of extra-heavy 10-in. channel iron with heavy cross members, insuring absolute rigidity. Both front and rear wheels are extra heavy, with wide tires, and are mounted on roller bearings. Standard track gage is used to insure tracking on rutted roads.

All gears on the main gear shaft in the hoisting mechanism and on the transmission shaft are specially cut and heat-treated steel gears. The engine clutch is used only when starting the engine, changing gears, or to throw out both drill and pump.

Torch for Construction Work

A construction torch which will not tip over and will burn for approximately forty-eight hours with one filling is manufactured by the McCloskey Torch Co., Toledo, Ohio, and is known as a bomb-shell torch. It is made of ⅛-in. rolled steel and has a 5½-lb. counter balance pressed in the bottom, which holds the torch in an upright position. It holds three quarts of oil and is furnished with 18-in. asbestos wicking which it is claimed, will never burn out. The torches burn fuel oil, and it is claimed they will remain lighted during the hardest wind and rain storms.



Non-tipping, forty-eight-hour torch

Meter Reads Volts or Amperes, Either A.C. or D.C.

With the increasing interest in the more efficient use of current both alternating and direct, the mine electrician is more and more coming to the use of testing instruments. The Martindale Electric Co., Cleveland, O., has announced a new combination ammeter and voltmeter that can be used for either alternating or direct current. This instrument is known as the Martindale universal portable ammeter and voltmeter.

It consists of a separate voltmeter and ammeter mounted together in the same case, in which space is also provided for five ammeter shunts, rated at 5, 10, 50, 100 and 300 amp. respectively. The voltmeter has an internal resistance of such value that the full scale may be 75, 150, 300 or 600 volts, depending upon which binding posts are used. This instrument is so constructed that either meter may be removed from the case and used separately.

Screens — The Deister Concentrator Co., Fort Wayne, Ind., has issued a pamphlet describing the Leahy No-Blind screen.

Acetylene—Catalog Section 5 of the Air Reduction Sales Co. covers Airco Davis-Bournonville acetylene generators.

Market and Financial News

Transvaal gold output for the month of November amounted to 840,276 oz. of fine gold, compared with 853,296 oz. in October and 787,633 oz. for November, 1925. Totals for the eleven-month periods, shown in the accompanying table, reveal that the output has been growing year by year since 1923.

	1923 Oz.	1924 Oz.	1925 Oz.	1926 Oz.
January	764,469	796,768	823,692	796,270
February	704,970	760,617	753,925	753,924
March	761,585	795,671	825,479	834,340
April	743,651	768,923	787,519	803,303
May	786,564	809,003	813,249	849,214
June	755,309	773,053	780,251	852,145
July	754,306	829,437	818,202	860,134
August	769,371	809,571	808,218	843,854
September	739,504	799,422	797,247	839,939
October	793,842	827,583	812,832	853,296
November	780,639	802,313	787,633	840,276
Eleven months	8,354,211	8,782,361	8,808,247	9,126,695
December	778,849	825,273	791,455	.....
Totals	9,133,060	9,597,634	9,599,702	.....

U. S. Smelting, Refining and Mining Co., during the eleven months ended Nov. 30, 1926, earned $191,000 less than in the corresponding period of 1925. Comparative figures for the two periods are shown in the accompanying table:

	1926	1925	1924
Net earnings, after interest and taxes	$5,614,437	$5,998,677	$4,958,747
Depreciation, depletion, and amortization	2,291,837	2,484,918	1,944,424
Net income	$3,322,600	$3,513,759	$3,014,323
Dividends on preferred stock	1,560,379	1,560,373	1,560,372
Surplus	$1,762,221	$1,953,386	$1,453,951

Burma Corporation, Ltd., during the quarter ended Sept. 30, realized gross revenue of £753,480, which after deducting £465,195 operating expenditures left a surplus of £288,285. Taxes and depreciation are calculated at £103,949. Production included the following:

73,900 tons of mill ore, assaying 18.1 oz. silver, 20.14 per cent lead, and 14.13 per cent zinc.

26,001 tons of lead concentrates, averaging 40.40 oz. of silver, 49.21 per cent lead, and 14.46 per cent zinc.

12,778 tons of zinc concentrate, averaging 13.23 oz. of silver, 6.96 per cent lead, and 45.67 per cent zinc.

28,943 tons of lead-bearing material, including 3,972 tons of high-grade ore, were smelted for a production of 12,781 tons of hard lead, assaying 82.37 oz. of silver per ton.

12,394 tons refined lead and 1,163,064 oz. refined silver.

3,200 tons copper matte, assaying 59.92 oz. of silver, 23.99 per cent lead, and 40.96 per cent copper.

Camp Bird, Ltd., carried a net credit of £199 to the balance sheet as the result of business for the year ended June 30, 1926. The Camp Bird mine, in the Ouray district in Colorado, has been kept in working condition and some ore has been mined on a royalty basis by leasers. The principal source of income has been from the company's holding of 651,985 shares of Santa Gertrudis Co., Ltd. The company also owns 203,750 shares of the Mexican Corporation, Ltd., which operates at Fresnillo and Teziutlan, both in Mexico. Income from these is small.

Imports and Exports of Ores and Metals in November, 1925 and 1926

Compiled from U. S. Department of Commerce Records

In pounds unless otherwise stated

Imports

	November, 1925	November, 1926
Antimony		
Ore, Gross weight	92,070	377,316
Ore, Antimony content	50,638	187,414
Liquated regulus or metal	2,377,902	2,151,721
Copper		
Ores	8,397,268	3,137,105
Concentrates	4,641,077	4,140,506
Regulus, coarse metal, cement copper	155,921	60,664
Imported from		
Spain	899,076	873,008
Canada	4,102,496	3,464,897
Mexico	2,502,122	445,100
Cuba	2,345,280	2,086,078
Chile	2,885,849	208,856
Peru	156,987	118,734
Other countries	302,456	141,602
Unrefined black, blister, and converter copper in pigs, bars, and other forms	28,583,748	31,339,350
Imported from		
Spain	.....	2,041,469
Canada	2,632,263	3,615,269
Mexico	4,652,048	4,360,239
Chile	1,121,145	1,001,476
Peru	8,674,490	9,954,744
Portuguese Africa	11,278,667	9,759,261
Other countries	225,135	606,892
Refined copper	13,052,403	10,548,007
Old and clippings for remanufacture	892,150	1,057,708
Composition metal, copper chief value	10,000	.....
Brass		
Old and clippings for remanufacture	528,529	686,300
Lead		
Ore and matte	6,884,529	10,061,122
Bullion or base bullion	14,238,341	9,156,870
Pigs and bars	169,649	4,213,708
Scrap lead, babbitt, solder, and other forms	57,577	602,498
Type metal and antimonial lead, Gross weight	2,024,444	222,645
Type metal and antimonial lead, Lead content	1,616,277	173,987
Manganese		
Ore, tons, Cuba, gross weight	1,021	3
Ore, tons, Other countries, manganese content	36,484	20,091
Pyrites, tons	26,458	27,545
Tin		
Ores, tons	14	8
Bars, blocks and pigs	10,244,729	15,415,353
Imported from		
United Kingdom	3,766,586	5,307,847
British Malaya	5,738,048	7,841,403
China	.....	112,083
Dutch East Indies	117,058	58,464
Hongkong	185,336	112,077
Australia	145,200	340,480
Other countries	292,501	1,642,999
Zinc		
Ore, zinc content, Free	.....	.....
Ore, zinc content, Dutiable	411,708	5,807,761
Blocks, pigs and old	797	785

Exports

	November, 1925	November, 1926
Copper		
Ores, concentrates, composition metal and unrefined	201,040	154,331
Refined in ingots, bars and other forms	55,651,193	83,387,113
Exported to		
Belgium	5,136,513	7,839,321
France	13,539,299	11,507,115
Germany	11,675,713	19,953,614
Italy	4,542,968	4,856,583
Netherlands	4,237,416	9,799,419
Spain	472,158	1,837,774
Sweden	2,466,442	2,153,898
United Kingdom	8,700,252	19,130,352
Other Europe	426,283	342,086
Canada	2,040,215	955,394
British India	.....	168,000
China	784,715	505
Japan	1,231,904	4,422,815
Other countries	397,315	420,237
Old and scrap	987,616	3,689,431
Pipes and tubes	199,569	263,212
Plates and sheets	251,362	187,916
Rods	3,555,804	4,496,410
Wire	449,028	918,282
Insulated copper wire and cable	2,683,632	1,289,252
Lead		
In pigs, bars, and other forms		
From domestic ore	1,871,092	182,882
From foreign ore	10,120,365	13,031,894
Exported to		
Belgium	672,122	112,045
France	1,568,475	806,726
Germany	2,371,385	5,377,499
Italy	560,056	.....
Netherlands	1,232,322	515,324
United Kingdom	4,873,132	5,265,505
Other Europe	56,024	.....
Brazil	448,174	337,116
Other South America	71,622	82,722
Japan	.....	560,164
Other countries	138,195	157,675
Other lead manufactures	2,185,894	1,007,916
Zinc		
Ore and concentrates, tons	13,329	5,543
Dross	1,422,917	1,379,754
Cast in slabs, blocks, or pigs	7,444,221	5,138,288
Exported to		
Belgium	336,029	.....
France	840,095	560,048
Germany	895,922	44,800
Italy	1,176,123	112,025
Netherlands	56,036	263,431
United Kingdom	2,918,953	1,411,854
Other Europe	336,713	.....
Argentina	.....	941,184
British India	224,034	.....
Other countries	660,316	1,804,946
Sheets, strips, other forms	361,884	614,327
Dust	402,491	87,231
Other zinc manufactures	154,722	1,781,504

The Market Report

Metals Decline in Dull Market

Copper Loses Most Ground—Lead and Zinc Easier—Little Change in Silver and Tin

New York, Jan. 5, 1927—Market-wise, the New Year has not opened auspiciously for the producers of non-ferrous metals. Looking back a year the fact is disclosed that with the single exception of tin each of the major metals is commanding a distinctly lower price. Copper at 14⅛c. a year ago was a full cent higher than today. The New York price for lead, 7.725c., is more than 1½c. lower; zinc, at 6.90c., is bringing about 1.6c. less per pound; and silver, at 53⅝c., is lower by nearly 15c. an ounce. The prevailing price of tin is about 3.5c. above that of the first week in 1926.

In making this comparison it should be pointed out that a year ago all of the prices were at comparatively high levels and little below the peaks reached during the closing month of 1925. Except for copper, which did not start to decline until about a month later, the price curves for each of the metals moved consistently downward during the first part of the year. If such a tendency should be repeated in 1927, levels lower than the minimum for several years would be reached. While the trend at the moment is definitely downward, there are many who feel that the bottom of the trough is close at hand. It is likely that this will prove true of some of the metals and possible that it will not prove true with regard to one or more of the others. One factor that should not be overlooked is the general decline in commodity prices during the year which in the long run will be reflected in lower operating costs and consequently will offset in some degree lower prices realized by metal producers. Moreover, it is a source of some satisfaction to know that unusually large production rather than curtailment in consumption by industry has been the biggest factor in the creation of easier market prices.

Average Metal Prices for December, 1926

Copper:	
New York Electrolytic	13.302
London Standard Spot	56.869
London Electrolytic Spot	64.114
Lead:	
New York	7.855
St. Louis	7.688
London Spot	28.932
London Forward	29.259
Silver:	
New York	53.466
London	24.733
Sterling Exchange	484.553
Zinc:	
St. Louis	7.018
London Spot	32.915
London Forward	32.895
Tin:	
99 per cent	66.635
Straits	68.514
London	306.994
Quicksilver	99.510
Antimony	13.142
Platinum:	
Refined	111.846
Crude	105.385
Aluminum, 98 per cent	26.934

Daily Prices of Metals

Dec. Jan.	Copper	Tin		Lead		Zinc
	Electrolytic, N. Y.	99 Per Cent	Straits	N. Y.	St. L.	St. L.
30	13.025	65.50	67.125	7.75@7.80	7.625	6.95@7.00
31	13.025	65.25	66.75	7.80	7.625	6.95@6.975
1			Holiday			
3	13.025	65.75	67.50	7.75@7.80	7.625	6.90@6.95
4	12.90	65.375	67.00	7.75@7.80	7.60	6.90@6.95
5	12.90	65.125	66.75	7.65@7.80	7.60	6.90
Av.	12.975	65.400	67.025	7.770	7.615	6.938

Average prices for the calendar week ending Jan. 1, 1927, are: copper: 13.140c.; 99 per cent tin, 65.075c.; Straits, 66.775c.; N. Y. lead, 7.795c.; St. L. lead, 7.630c.; zinc, 6.990c.; and silver, 53.925c.

The above quotations are our appraisal of the major markets for domestic consumption based on sales reported by producers and agencies. They are reduced to the basis of cash, New York or St. Louis, as noted. All prices are in cents per pound.

Copper, lead, and zinc quotations are based on sales for both prompt and future deliveries; tin quotations are for prompt delivery only.

In the trade, copper prices usually are quoted on a delivered basis; i.e., delivered at consumer's plant. As delivery and interest charges vary with the destination, the figures shown above are net prices at refineries on the Atlantic seaboard.

Quotations for copper are for ordinary forms of wire bars, ingot bars, and cakes. For ingots an extra 0.05c. per lb. is charged and there are other extras for other shapes. Cathodes are sold at a discount of 0.125c. per lb.

Quotations for zinc are for ordinary Prime Western brands. Zinc in New York is now quoted at 0.35c. per pound above St. Louis, this being the freight rate between the two points.

Quotations for lead reflect prices obtained for common lead, and do not include grades on which a premium is asked.

London

Dec. Jan.	Copper			Tin		Lead		Zinc	
	Standard		Electrolytic						
	Spot	3M		Spot	3M	Spot	3M	Spot	3M
30	56¼	57⅝	63½	301½	296¼	28 15/16	29⅛	32¾	32¾
31	56⅛	57	63½	300¼	294⅝	28 13/16	29	32¾	32¾
3	56	56⅞	63½	303	297	28 9/16	28⅞	32¾	32 11/16
4	55⅞	56⅝	63	301	295	28 7/16	28⅝	32⅜	32 7/16
5	55½	56¼	62	299½	294½	27⅞	28 3/16	32	32 1/16

The above table gives the closing quotations on the London Metal Exchange. All prices in pounds sterling per ton of 2,240 lb.

Silver, Gold, and Sterling Exchange

Dec. Jan.	Sterling Exchange "Checks"	Silver		Gold London	Jan.	Sterling Exchange "Checks"	Silver		Gold London
		New York	London				New York	London	
30	4.84 7/8	54⅛	25 1/16	84s11½d	3	4.84¾	54	25	84s11½d
31	4.84⅝	54	25	84s10¾d	4	4.84⅞	53¾	24 15/16	84s10½d
1	Holiday		25 1/16	.....	5	4.84⅞	53⅝	24¾	84s11½d
					Avg.		53.900		

New York quotations are as reported by Handy & Harman and are in cents per troy ounce of bar silver, 999 fine. London silver quotations are in pence per troy ounce of sterling silver, 925 fine. Sterling quotations represent the demand market in the afternoon. Cables command one-half cent premium.

Copper at 13⅛c. Deliverd

The copper market continued its downward course during the week, one sale late this afternoon having been closed at 13.10c. delivered in Connecticut. If anything, the decline has been more precipitous this week than heretofore. Last Thursday a large volume of business was done at 13.25c. with lesser quantities bringing 13⅜c. in the East and some as high as 13.50c. at destinations having high freight rates. Yesterday and today any reasonable quantity seems to be available at 13⅛c. delivered in Connecticut, and a fair business has been done at that figure. At the same time a good sale at 13⅜c. was made for delivery in the Middle West. Some sellers are quoting nominally higher figures and are virtually out of the market. Though the entire volume of business exceeded that of either of the two preceding weeks, it has not been up to normal. Tuesday afternoon the export association reduced its c.i.f. price from 13.85c. to 13.50c. This brings the price in line with about 13.25c. delivered in the domestic market. One-

quarter cent is approximately the differential between the Connecticut and c.i.f. prices. It is understood that prior to the reduction dealers abroad were selling at 13.725c. c.i.f., the copper presumably being metal for which they paid close to 14.50c. just prior to the time that Copper Exporters commenced to function. If this is so the speculators apparently were burned. Prior to yesterday 13.35c. had been done in the f.a.s. market, but today 13.15c. or a little better is the ruling price.

Lead Again Weakens

Lead prices have again been anything but firm in the week ending today, though there was no great pressure on the market. The American Smelting & Refining Co. still continued to quote 7.80c., New York, this price obtaining of course on contract sales, but consumers were averse to paying more than 7¾c., at which price a moderate tonnage was booked. Today, forward lead sold as low as 7.65c. New York. A little carload business, chiefly from Middle Western producers, brought somewhat higher prices. The St. Louis and Chicago markets were also quiet, though not quotably lower than a week ago. The leading seller in the St. Louis market did most of his business on a 7.625c. basis until yesterday, when orders were accepted at 7.60c., these prices being substantially the same as were secured by other sellers. Chicago was about 7½ points higher, though corroding lead, which ordinarily brings $2 a ton premium, was sold as low as 7.70c. Practically all of the inquiry has been for January shipment, though sellers were willing to book business further ahead at the same prices. One round lot for March was accepted. Cable manufacturers have been the only buyers of importance for the last two weeks.

London prices have declined every day since last Thursday, today's recession of 11s. 3d. on spot being especially sharp. Sales were not large, even at the sharply cut prices, and foreign consumption is reported to be disappointing. Today's London price is equivalent to only about 7.90c., New York, for duty-paid foreign bullion lead.

Zinc at 6.90c.

After a quiet week, with little change in prices, zinc suffered two successive declines yesterday and today in London. This has been reflected in an easier tone in the domestic market. It is reported that Belgian smelters, having contracted for a large proportion of the Australian output of concentrate, have been hedging in slab zinc in London and that this has been responsible for the decline there. On the other hand, domestic galvanizers are hesitant buyers on the ground that they foresee some falling off in their sales. However, producers are not anxious sellers and feel confident that further declines are unlikely. High-Grade is quoted at 9c. delivered in the East, with the market quiet.

Tin Continues Quiet

Tin prices in London advanced on Thursday, and again on Monday, accompanied by a corresponding movement in New York, but the trend of the other metals had its effect on tin, and today's price is back to about the level of a week ago. Consumers have bought only in small quantities and there has been little life to the market. Spot again commands a slight premium, but it is expected that there will be plenty of tin arriving in the next few weeks to take care of the demand. March tin has sold for about 1c. less than the price of prompt.

Exchanges Steady

Few changes have taken place in the foreign exchange market. Closing cable quotations on Tuesday, Jan. 4, were as follows: francs, 3.945c.; lire, 4.47c.; and marks, 23.78c. Canadian dollars, ⅛ per cent discount.

Silver Steady But Weak

During the past week silver prices fluctuated within narrow limits, the chief support coming from India, which was a buyer at about the present level. China has remained inactive and while the market closes steady the future tendency is uncertain.

Mexican Dollars (Old Mexican pesos): Dec. 30th, 41⅛c.; 31st, 41c.; Jan. 1st, holiday; 3d, 41c.; 4th, 40¾c.; 5th, 40⅝c.

Joplin Blende and Lead Ore Prices Unchanged—Year's Value $55,920,650

Joplin, Mo., Dec. 31, 1926

Blende	
High	$50.20
Premium blende, basis 60 per cent zinc	$47.00@ 48.00
Prime Western, basis 60 per cent zinc	46.00
Fines and slimes, basis 60 per cent zinc	44.00@ 41.00
Average settling price, all zinc	45.31
Galena	
High	$102.20
Basis 80 per cent lead	97.50
Average settling price, all lead	100.95

Shipments for the week: Blende, 18,300; lead, 3,362 tons. Value, all ores the week, $1,169,580. Shipments for the year: Blende, 860,828; calamine, 1,514; lead, 130,081 tons. Value, all ores, 1926, $55,920,650, compared with $58,747,000 in 1925.

Blende sales totaled only 9,720 tons and production for the week was lowered to 12,500 tons. With only 21,000 tons of concentrate in the bins and almost 10,000 tons of this sold, the net reserve stock at the end of the year is less than that of a year ago, having fallen to one of the lowest points of record.

Stocks of lead are estimated at 12,000 tons, with around 2,100 tons sold. Sellers accepted prices current on a number of bins before the decline below the $100 basis price, consequently the ore shipped this week and a portion of that for next week's shipment will be settled for on a basis $2.50 per ton higher than current quotations.

Platteville, Wis., Jan. 1, 1927

Zinc Blende	Per Ton
Blende, basis 60 per cent zinc	$48.75
Lead Ore	
Lead, basis 80 per cent lead	$100.00

Shipments for the week: Blende, 1,236 tons; lead, 45 tons. Shipments for the year: Blende, 57,998; lead, 1,911 tons. Shipments for the week to separating plants, 2,294 tons blende.

Steel and Coke Firm—Pig Iron Quiet

Pittsburgh, Jan. 4, 1927

The steel market has been quiet throughout the last week, reflecting the season of year, with holiday interruptions and inventory taking. Little business has been done in special orders, for freight cars, fabricated structural work, or other forms. General-line buying has been of fair proportions.

The steel trade as a whole has been indisposed to form any definite opinion as to what the new year will be like in the matter of demand, but it sees no particular reason why the large tonnage of 1926 should not be duplicated, perhaps with additions in some lines.

Mill operations last week were scarcely affected at all by the holiday and a general estimate of a 75 per cent operation holds good both for last week and for this week.

Shading in sheets continues, and cold-rolled strips are weak. Otherwise steel prices are very firm and, indeed, rigid. Mills are encouraged by the fact that prices have held so well in face of strenuous competition.

Pig Iron—The Valley market continues quiet. On a fair-sized lot of bessemer a 50c. concession from the former figure would be made. Bessemer, $19.50@$20; basic, $18.50; foundry, $18.50@$19, f.o.b. Valley furnaces.

Connellsville Coke—The market presents a firmer tone, it being now fairly well understood that wages will not be reduced. Spot furnace, $3.50@$4; spot foundry, $4.75@$5.25.

Other Metals

Quotations cover large wholesale lots, f.o.b. New York, unless otherwise specified. London prices are according to latest mail advices.

Aluminum—Per lb., 99 per cent grade, 27c.; 98 per cent grade, 26½@27c. Market quiet. London, 98 per cent, £105@£107 per long ton for domestic purposes.

Antimony—Per lb., duty paid, spot: Chinese brands, 12½@13c.; February, 12½@13c. Cookson's "C" grade, spot, 17½c. Market quiet with little consuming demand in evidence.

Chinese needle, lump, 8c. Standard powdered needle, 200 mesh, 10c. White oxide, Chinese, 99 per cent Sb_2O_3, 14½c. Nominal.

Bismuth—Per lb., in ton lots, $2.70@$2.75. London, 10s.

Cadmium—Per lb., 60c. London, 1s. 10½d.@1s. 11d. for American metal; 1s. 10d. for Australian metal.

Cobalt—F.o.b. Canadian works, per lb., shot, 96@98 per cent, $2.50. Black oxide, 70 per cent, $2.10. London, 10s. for metal; 8s. for black oxide; 8s. 10d. for gray.

Germanium Oxide—Per gm. in 300- to 500-gm. lots, $5.

Iridium—Per oz., $120@$125 for 98@99 per cent sponge and powder. London, £32½ in iridio-platinum; £17@£20, nominal, for sponge and powder.

[1]**Lithium**—Per lb., 95@96 per cent grade in 1- to 5-lb. lots, $65.

Magnesium—Per lb., in ton lots, 8-lb. ingots (3x3x15 in.), 75c.; 3-lb. sticks (1⅜x33 in.) 80c.; 10-oz. sticks, (1x12 in.), 90c. Market firm. Increasing demand reported for light alloys. London, 3s. 9d.@4s. 3d. for 99 per cent ingots or sticks.

[1]**Molybdenum**—Per kg., 99 per cent, $25; C. P. metal, $80.

Monel Metal—Base price for shot, 32c. per pound.

Nickel — Per lb., ingot, 35c.; shot, 36c.; electrolytic, 39c. (99.75 per cent grade). London, £170@£175 per long ton according to quantity. Demand continues good.

Osmium—Per oz., $60@$65; London, £16@£19.

Palladium—Per. oz., $58@$70, depending on quantity and terms. Pure metal as a constituent of crude platinum, $55@$60 per oz. London, £11@£12, though nominal prices are higher.

Platinum — Official price on refined metal $110 per oz. Price reduced $2 on Thursday, Dec. 30. Open market cash sales of large lots at $105. Pure metal as a constituent of crude platinum, $103.50.

London, £23 per oz. for refined, and £20½ for crude and scrap. Dull.

Quicksilver—Per 75-lb. flask, $100. San Francisco wires $100.33. The price has been strengthening for several weeks. London, firmer at £17 15s.

Radium—$70 per mg. radium content.

Rhodium—Per oz., $65@$75; London, £10@£14. Nominal.

Ruthenium—Per oz., $50@$55, nominal. London, £8@£10.

Selenium — Black, powdered, amorphous, 99.5 per cent pure, $1.90@$2 per lb. in ton lots. London, 7s. 6d.@7s. 8d.

Tellurium—Per lb., $2.

[1]**Thallium Metal**—Ingot, 99 per cent pure, $10 per lb. in 25-lb. lots.

Tungsten Powder—Per lb., 97 to 98 per cent pure, $1.05.

[1]**Zirconium Metal**—Per lb., 98 per cent grade, $30 in 5- to 10-lb. lots.

Metallic Ores

Chrome Ore—Per net ton, f.o.b. eastern shipping points, $21@$24 for 45 to 50 per cent Cr_2O_3 ore. Prices firm and demand good.

Iron Ore—Lake Superior ores, per long ton, lower Lake ports, established 1926 season prices:

Mesabi, non-bessemer, 51½ per cent iron, $4.25. Old Range, $4.40.

Mesabi, bessemer, 51½ per cent iron, $4.40. Old Range bessemer, 51½ per cent, $4.55.

High-phosphorus foundry, over 0.18 per cent P, $4.15.

Eastern ores. cents per unit, delivered at furnaces: Foundry and basic, 53 to 63 per cent, 9@10½c.

Foreign ores, f.o.b. cars Atlantic ports, cents per unit:

Swedish and Norwegian, low-phosphorus, 68 per cent, 10¼@10¾c.

Spanish low-phosphorus, 52@54 per cent, 10@11c.

Algerian, low-phosphorus, 9¼@9¾c.

Spanish foundry or basic, 50@54 per cent, 8¾@9¼c.

Swedish foundry or basic, 66@68 per cent, 9@9½c.

Manganese Ore—Per long ton unit of Mn, c.i.f. North Atlantic ports, minimum 47 per cent Mn, 36@38c. Caucasian (washed), 53@55 per cent, 38@40c.

[1]Chemical grades, powdered, coarse or fine, 82@87 per cent MnO_2, Brazilian and Cuban, $70@$80 per ton in carloads.

Molybdenum Ore—Per lb. of MoS_2 for 85 per cent MoS_2 concentrates f.o.b. *Colorado*, 48@50c.

Tantalum Ore—Nominally, 75c. per lb. for ore containing 60 per cent Ta_2O_5 and 20 per cent Cb_2O_5.

Titanium Ore—Ilmenite, 52 per cent TiO_2, f.o.b. Atlantic seaboard, $12@$15 per gross ton. High-grade, imported, 55 per cent TiO_2, 1½c. per lb. Low-grade, domestic, 32 to 35 per cent, about $7@$8 per gross ton.

Tungsten Ore—Per unit of WO_3, N.Y.: Wolframite, $10.75@$11; Western scheelite, $11.25@$11.50.

Uranium Ore—Minimum 5 per cent U_3O_8 per pound of U_3O_8 contained, $5, f.o.b. Montrose, Colo.

Vanadium Ore—Containing 5 per cent V_2O_5, 25c. per lb. of V_2O_5, f.o.b. Montrose, Colo.

Foreign concentrate (lead vanadate) 12 to 18 per cent V_2O_5, 55@60c. per pound V_2O_5, duty paid, seaboard. Nominal.

Non-Metallic Minerals

Prices received for non-metallic minerals vary widely and depend upon the physical and chemical characteristics of the commodity. Hence the following quotations can serve only as a general guide to the prices obtained by producers and dealers in different parts of the United States for their own product. In the last analysis the value of a particular non-metallic mineral can be ascertained only by direct negotiation between buyer and seller.

[1]**Amblygonite**—8@9 per cent lithium oxide, $50@$60 per ton, f.o.b. mines.

Asbestos—F.o.b. *Quebec* mines, tax and bags included, per ton:

Crude No. 1, $525; crude No. 2, $300; spinning fibers, $190; magnesia and compressed sheet fibers, $125@$150; shingle stock, $80; paper stock, $40@$45; cement stock, $25; short fibers, $10@$17.50; floats, $15. Active market for all spinning grades and shingle stock, but there is an overproduction of shorter grades. Mines are running at full capacity. Market active for spinning grades and shingle stock. Overproduction of shorter grades.

No. 1 Rhodesian crude, $325; No. 2, $250 per ton, c.i.f. New York.

Barytes—F.o.b. mines, per ton. bags extra:

Georgia: Barytes ore, crude. $7.50. Demand good, wet ground, off-color, $12@$18, depending on analysis.

Missouri: Water ground and floated, bleached, $23; $25 in less than car lots. f.o.b. works. Crude ore, 93 per cent $BaSO_4$, not to exceed 1 per cent iron, $8, f.o.b. mines. Market good.

Bauxite—No. 1 chemical ore, over 60 per cent Al_2O_3, less than 5 per cent SiO_2, and less than 2 per cent Fe_2O_3, $8 per long ton, f.o.b. Georgia mines.

Foreign, per metric ton, c.i.f.: Dalmatian, low SiO_2, $5@$6.50; Istrian, $5.50@$7; French, red, $6@$7.50.

Borax—Carload lots, in bags, per lb.; crystals, 4½c.; granulated or powdered, 4c.; f.o.b. plant, *Pennsylvania*.

[1]**Celestite**—90 per cent $SrSO_4$, finely powdered, $27 per ton in carload lots.

Chalk—Crude, in bulk, per ton c.i.f. New York, $4.75@$5.

China Clay (Kaolin)—F.o.b. *Virginia* mines, per ton; crude, lump, No. 1, $7; crude No. 2, $5.50; washed, $8; powdered and air-floated, $10@$20; ground, $7@$10.

Florida, pressed pottery, bulk, $13; ground, No. 1, $20; No. 2, $15. Sprayed mineral flour No. 1, $20; No. 2, $17.

1A grades, domestic, $16, f.o.b. *Delaware* plants. Good demand.

Imported English, f.o.b. American ports: Lumps, $13@$20; powdered, $45@$50.

Diatomite—Per short ton, f.o.b. plant: Kiln-fired brick, $65; kiln-fired aggregate, ¼ in., $45; insulating powder, $30; natural aggregate, ¼ in., $20; air-floated powder, $40. Over 85 per cent silica, 98 per cent through 200 mesh, $14.50@$16 depending on quantity.

Emery — F.o.b. *Pennsylvania* and *New York* in 350-lb. kegs, per lb. Greek Naxos, 6½c.; Turkish, 6½c.; Khasia, 5½c.; domestic, 3½c. Market good.

Feldspar — F.o.b. mine or grinding plant:

North Carolina: No. 1 pottery grade, $6.50@$7.50 per long ton. Market good.

New Hampshire: Pottery grade, $8 per ton; soap grade, $8.50. Market fair.

New York: Per ton, f.o.b. cars, No. 1 crude, $9. Market good.

Tennessee: No. 1, pottery, 140 mesh, $16 per ton; 200 mesh, $18. No. 2, enamel, 140 mesh, $14; 200 mesh, $16. Demand good.

Maine: Pottery grade, ground, $19 per ton. Market good.

Fluorspar—F.o.b. *Kentucky* and *Illinois* mines, per short ton:

Gravel, not less than 85 per cent CaF_2, and not over 5 per cent SiO_2, $18. Foundry lump, 85-5, $20. Ground, 95 to 98 per cent CaF_2, and not over 2½ per cent SiO_2, $32.50 in bulk; $36.50 in bags or barrels. Acid lump, 98-1, $30 in car lots. No change in conditions.

New Mexico: 85-5 gravel, $16.25; 85-5 lump, $15.50; 93-3 lump, $19; 96-3, ground 100 mesh, $35, bulk; $40 bags. Market strong.

Foreign spar, duty paid, $17@$17.50, tidewater.

Fuller's Earth—Per ton, f.o.b. *Florida:* 16 to 30 mesh, $16.50; 30 to 60 mesh, $18; 60 to 100 mesh, $15; 100 mesh "up," $8; 200 mesh "up," $15. Market fair at unchanged prices.

Powdered, imported, duty paid, $24@$25 per ton.

Garnet — Domestic, per ton f.o.b. mines, $85. Market easy.

Spanish grades, $60, c.i.f. port of entry.

Gilsonite—Per ton, carload lots, f.o.b. mines *Colorado:*

[1]Price furnished by Foote Mineral Co., Philadelphia.

Jet asphaltum, $36; selects, $33; seconds (mine run), $25.50.

Graphite—F.o.b. *New York*, per lb.: Ceylon lump, 8@9c.; chip, 7@8c.; dust, 3@6c.; Madagascar flake, 6½@7c. Market quiet.

High-grade, finely ground, 12c. up; medium grade, 8c. up. No. 1 flake, 10c. up; fine flake, 9c. up. Foundry facings 4c. up. Amorphous, fine ground, 4c. up; fine ground crystalline, 7@12c. Crude amorphous graphite, $15@$35 per ton according to grade. Market quiet and competition keen.

Greensand—Per ton, f.o.b. cars, *New Jersey:* screened and bagged, best grade in carload lots, $30. Fair demand.

Gypsum—Per ton f.o.b. mill, depending upon location: Crushed, $2.75@$3; ground, $4@$8; agricultural, $6@$12; calcined, $7@$10.

Iron Oxide (See Ocher)—Standard Spanish red, 2½@4c. per lb.; domestic earth, 2@4½c.

Kaolin—See China Clay.

[1]**Lepidolite**—20@$30 per ton for ordinary grades. Nominal.

Limestone — F.o.b. shipping points, depending on location: either lump or crushed, 75c.@$2 per ton.

Agricultural, 75c. up to $4 or $5 for crushed or pulverized. Prices depend upon source, purity, and fineness.

Magnesite—Per short ton, f.o.b. *California* mines: Grade "A" calcined, 80 per cent through 200 mesh, $40; grade B, $38; dead burned, $33; crude, $14. F.o.b. eastern seaboard, calcined, $40. Market fair.

Mica—F.o.b. plant, per ton:

New Hampshire: Mine run, $380, clean shop scrap, $25; mine scrap, $22. White dry ground, 20 mesh, $30; 40 mesh, $40; 60 mesh, $55; 100 mesh, $70; 200 mesh, $85. Fair volume of business.

Madagascar, amber, dark, free from iron, per lb., f.o.b. *New York*, duty paid: No. A1, $2.75@$3; No. 1, $2.60; No. 2, $2.30@$2.50; No. 3, $1.25; No. 4, 75c.; No. 5, 40@45c. Grades depend on size of sheets. Good demand for Nos. 2 and 4.

[1]**Monazite**—Minimum 6 per cent ThO_2, $120 per ton.

Ocher—F.o.b. *Georgia* mines, per ton: $22.50@$25 in sacks; $25@$30 in barrels; washed and water floated, $25@$28; second grade, 99 per cent through 225 mesh, $19. Market good.

Phosphate—Per long ton, f.a.s. or f.o.b. mines:

Florida, pebble, f.a.s., for export: 76@77 per cent, $7; 75 per cent, $6.25; 74@75 per cent, $6; 70 per cent, $4.50; 68 per cent, $4.10; 66 per cent, $4. Business slow account high water freight rates.

Florida, pebble domestic: 76@77 per cent, $6; 75 per cent, $5.25; 74@75 per cent, $5; 72 per cent, $4; 70 per cent, $3.50. Prices firm but business slow on account cautious attitude domestic fertilizer manufacturers because of cotton situation.

Tennessee, ground, 95 per cent through 100 mesh, basis 65 per cent B.P.L. (tri-calcium phosphate), $8 per short ton, with unit differential of 20c. per ton. Market slow. Lump rock for acid manufacturers per gross ton $5.75 on 75 per cent basis; $4.50 for 72 per cent basis.

Potash—Advances in the domestic market in line with reported action of National Potash Council in Germany raising prices 9½ per cent have not materialized as yet. The ruling contract prices are as follows:

	Bags	Bulk
Muriate of potash 80 @ 85 per cent, basis 80 per cent....	36.40	34.80
Sulphate of potash 90@95 per cent, basis 90 per cent....	47.30	45.70
Sulphate of potash-magnesia 48@53 per cent, basis 48 per cent	27.25	25.65
Manure salt 30 per cent....	21.75	18.75
Manure salt 20 per cent.....	15.40	12.40
Kainit 14@16 per cent.....	12.50	9.50
Kainit 12.4 per cent.....	12.00	9.00

Two thousand pounds net weight, c.i.f. Atlantic and Gulf ports. German weights, tares and analyses.

Discounts: 5 per cent on minimum of 50 tons K_2O; 6 per cent on 100 tons; 7 per cent on 300 tons; 10 per cent on 500 tons.

Pumice Stone—In barrels, per lb., powdered, 2½@4c.; selected lumps, 5@7c.; lumps in bags, 3@5c.

Pyrites—Tharsis, per long ton unit of sulphur, c.i.f. U. S. ports; guaranteed 48 per cent sulphur, furnace size, 2½-in. diameter, 13¾c. Cinder from ore to remain property of buyers. Good inquiry reported.

[1]**Quartz Rock Crystals**—Colorless, clear and flawed, pieces ¼ to ½ lb. in weight, 40c. per lb. in ton lots. For optical purposes, double above prices.

Silica—Water ground and floated, per ton in bags f.o.b. Illinois: 400 mesh, $31; 350 mesh, $26; 250 mesh, $18. Market fair.

Glass sand, f.o.b. producing plant, 75c.@$5 per ton; molding sand, 65c.@$3.50; blast sand, $1.35@$3.50.

[1]**Spodumene**—$20@$30 per ton, depending upon lithium content. Nominal.

Sulphur—$18 per ton for domestic, f.o.b. *Texas* mines; $24 for export, f.a.s. Atlantic ports. Good shipment against contracts. Open prices $1 higher than above.

Talc—Per ton, carload lots, f.o.b. works, containers included:

Vermont: 99 per cent through 200 mesh, extra white, $10.50; 96 per cent through 200 mesh, medium white, $9@$10; packed in 50-lb. paper bags. Strong competition; buyers' market. Prices easier.

New York: Double air-floated, 200 mesh, $13.75; 325 mesh, $14.75. Demand fair.

Georgia: Powdered, gray, $7.50@$10; yellow, $9@$12; red, $11@$13; roofing, $7.50@$9. Market fair.

New Jersey: Soapstone, ground, $10@$12; market good.

Tripoli—Per short ton, burlap bags, paper liners, minimum carload 30 tons, f.o.b. *Missouri:* Once ground through 40 mesh: rose and cream colored, $14. Double ground through 110 mesh: rose and cream, $17. Air-floated through 200 mesh: rose and cream, $25; mill run, $15. Business good.

[1]Price furnished by Foote Mineral Co., Philadelphia.

[1]**Zircon**—Freight allowed east of Mississippi River; 95 per cent, 3c. per lb., f.o.b. mines, in carload lots.

Mineral Products

Arsenious Oxide (white arsenic)—3½@3¾c. per lb. London, £16 10s. per long ton for Cornish white.

Calcium Molybdate—$1.20 per lb. of contained Mo, delivered.

Copper Sulphate — 4.40c. per lb. for either large or small crystals.

Sodium Nitrate—Crude, per 100 lb. ex vessel, Atlantic ports, $2.60 for spot; future delivery $2.65.

Sodium Sulphate (Salt Cake)—Per ton, bulk, f.o.b. works, $20@$22.

Zinc Oxide—Per lb. in bags, in car lots: Lead-free, 6½c.; 10, 20 or 35 per cent leaded grades, 6½c.; French red seal, 9⅜c.; prices down ½c.

Ferro-Alloys

[1]**Ferrocerium**—Per lb., $5.50.

Ferrochrome—Per lb. of contained chromium, 60@70 per cent chromium, 4 to 6 per cent carbon, 11½c. Market active.

Ferromanganese—Domestic and foreign, 78@82 per cent, $100 per gross ton furnace, for delivery during first half of 1927. Contracts generally closed for first quarter. Spiegeleisen, 19@21 per cent, $36@$37 on carload business, f.o.b. furnace; 16@19 per cent, $34@$35.

Ferrophosphorus—Electrolytic, 18 per cent P, $91 per ton; 24 per cent, $122.50; f.o.b. *Alabama* and *Tennessee*.

Ferrosilicon—Per gross ton, f.o.b. works, freight allowed on carload lots east of Mississippi River: 50 per cent, $85; 75 per cent, $145; 14@16 per cent, $45. Active market.

Ferrotitanium—For 15 to 18 per cent material, $200 per ton, f.o.b. Niagara Falls, N. Y.

Ferrotungsten—$1.02@$1.05 per lb. of W contained, f.o.b. works. Active but spotty.

[1]**Ferro-uranium**—30 to 40 per cent U, $4.50 per lb. of U contained, f.o.b. works in 500-lb. lots.

Ferrovanadium—Per lb. of V contained, f.o.b. works, $3.15@$3.75, depending on grade.

Metal Products

Rolled Copper — Sheet, 22c.; wire, 15½c. per lb., f.o.b. mill.

Lead Sheets—Full rolled, 11¾c. per lb.; clipped, 12c.

Nickel Silver—29c. per lb. for 18 per cent nickel Grade A sheets.

Yellow (Muntz) Metal — Dimension sheets, 19⅜c. per lb.; rods, 16⅜c. per lb.

Zinc Sheets—11½c. per lb., f.o.b. works.

Refractories

Chrome Brick—$45 per net ton, f.o.b. shipping point.

Fireclay Brick—First quality, $40@$43 per M., Ohio, Kentucky, Central Pennsylvania; second quality, $35@$40.

Magnesite Brick—9-in. straights, $65 per net ton, f.o.b. works.

Silica Brick—$42 per M., Pennsylvania and Ohio; $52 Alabama and Illinois.

[1]**Zirkite**—Powdered, 80 per cent ZrO_2, 2½c. per lb. Brick, straights, 80c.@$1 each.

Metal Statistics

Monthly Average Prices of Metals

Silver

	New York 1926	New York 1927	London Spot 1926	London Spot 1927	Sterling Exchange 1926	Sterling Exchange 1927
January	67.795	.....	31.322	.....	485.295	.....
February	66.773	.....	30.797	.....	485.852	.....
March	65.880	.....	30.299	.....	485.606	.....
April	64.409	.....	29.682	.....	485.702	.....
May	65.075	.....	30.125	.....	485.485	.....
June	65.481	.....	30.248	.....	486.000	.....
July	64.793	.....	29.861	.....	485.755	.....
August	62.380	.....	28.773	.....	485.293	.....
September	60.580	.....	27.904	.....	484.845	.....
October	54.505	.....	25.291	.....	484.475	.....
November	54.141	.....	25.192	.....	484.359	.....
December	53.466	.....	24.733	.....	484.553	.....
Year	62.107	.....	28.686	.....	485.268	.....

New York quotations, cents per ounce troy, 999 fine. London, pence per ounce, sterling silver, 925 fine.

Copper

	New York Electrolytic 1926	New York Electrolytic 1927	London Spot Standard 1926	London Spot Standard 1927	London Spot Electrolytic 1926	London Spot Electrolytic 1927
January	13.822	.....	59.013	.....	65.325	.....
February	13.999	.....	59.669	.....	66.375	.....
March	13.859	.....	58.603	.....	65.489	.....
April	13.706	.....	57.200	.....	64.600	.....
May	13.599	.....	56.494	.....	64.313	.....
June	13.656	.....	56.778	.....	64.591	.....
July	13.924	.....	57.864	.....	65.625	.....
August	14.174	.....	58.857	.....	66.857	.....
September	14.062	.....	58.705	.....	66.528	.....
October	13.862	.....	58.304	.....	66.298	.....
November	13.576	.....	57.293	.....	65.551	.....
December	13.302	.....	56.869	.....	64.114	.....
Year	13.795	.....	57.971	.....	65.472	.....

New York quotations, cents per pound. London, pounds sterling per long ton.

Lead

	New York 1926	New York 1927	St. Louis 1926	St. Louis 1927	London 1926 Spot	London 1926 3 Mos.	London 1927 Spot	London 1927 3 Mos.
January	9.255	.....	9.102	.....	34.778	34.584	.....	.....
February	9.154	.....	8.991	.....	33.903	33.903	.....	.....
March	8.386	.....	8.165	.....	31.625	31.921	.....	.....
April	7.971	.....	7.764	.....	28.775	29.284	.....	.....
May	7.751	.....	7.538	.....	28.253	28.731	.....	.....
June	8.033	.....	7.876	.....	29.986	30.142	.....	.....
July	8.499	.....	8.383	.....	31.716	31.545	.....	.....
August	8.908	.....	8.722	.....	32.756	32.345	.....	.....
September	8.786	.....	8.515	.....	32.085	31.790	.....	.....
October	8.402	.....	8.130	.....	30.821	30.702	.....	.....
November	8.005	.....	7.800	.....	29.270	29.563	.....	.....
December	7.855	.....	7.688	.....	28.932	29.259	.....	.....
Year	8.417	.....	8.223	.....	31.075	31.147	.....	.....

New York and St. Louis quotations, cents per pound. London, pounds sterling per long ton.

Tin

	New York 1926 99%	New York 1927 99%	New York 1926 Straits	New York 1927 Straits	London 1926 Spot	London 1927 Spot
January	61.415	.....	62.275	.....	282.038	.....
February	62.653	.....	63.705	.....	287.107	.....
March	63.472	.....	64.505	.....	292.288	.....
April	61.962	.....	63.389	.....	281.388	.....
May	60.165	.....	62.305	.....	270.125	.....
June	58.409	.....	60.611	.....	268.352	.....
July	61.365	.....	63.091	.....	282.102	.....
August	63.875	.....	65.260	.....	293.690	.....
September	66.535	.....	68.895	.....	306.273	.....
October	68.225	.....	70.245	.....	312.548	.....
November	68.667	.....	70.630	.....	309.284	.....
December	66.635	.....	68.514	.....	306.994	.....
Year	63.615	.....	65.285	.....	291.016	.....

New York quotations, cents per pound. London, pounds sterling per long ton.

Zinc

	St. Louis 1926	St. Louis 1927	London 1926 Spot	London 1926 3 Mos.	London 1927 Spot	London 1927 3 Mos.
January	8.304	.....	38.059	37.363	.....	.....
February	7.759	.....	36.053	35.956	.....	.....
March	7.332	.....	34.090	34.247	.....	.....
April	7.001	.....	32.503	32.863	.....	.....
May	6.821	.....	32.038	32.413	.....	.....
June	7.112	.....	33.244	33.398	.....	.....
July	7.411	.....	34.045	34.270	.....	.....
August	7.376	.....	34.173	34.524	.....	.....
September	7.413	.....	34.389	34.415	.....	.....
October	7.296	.....	34.256	34.146	.....	.....
November	7.199	.....	33.491	33.483	.....	.....
December	7.018	.....	32.915	32.895	.....	.....
Year	7.337	.....	34.105	34.164	.....	.....

St. Louis quotations, cents per pound. London, pounds sterling per long ton.

Antimony, Quicksilver and Platinum

	Antimony (a) New York 1926	Antimony (a) New York 1927	Quicksilver (b) New York 1926	Quicksilver (b) New York 1927	Platinum (c) Refined New York 1926	Platinum (c) Refined New York 1927	Platinum (c) Crude New York 1926	Platinum (c) Crude New York 1927
Jan.	23.490	.....	87.960	.....	118.200	.....	113.200	.....
Feb.	21.676	.....	87.580	.....	113.909	.....	108.341	.....
March	19.708	.....	88.194	.....	112.000	.....	106.278	.....
April	17.462	.....	89.769	.....	111.538	.....	103.731	.....
May	12.170	.....	91.365	.....	108.960	.....	102.900	.....
June	11.106	.....	91.346	.....	111.000	.....	106.615	.....
July	14.490	.....	90.163	.....	114.692	.....	109.000	.....
Aug.	15.957	.....	89.260	.....	116.000	.....	108.692	.....
Sept.	15.325	.....	91.425	.....	116.840	.....	108.600	.....
Oct.	13.943	.....	97.260	.....	112.240	.....	106.000	.....
Nov.	13.385	.....	99.000	.....	112.000	.....	105.250	.....
Dec.	13.142	.....	99.510	.....	111.846	.....	105.385	.....
Year	15.988	.....	91.903	.....	113.269	.....	106.999	.....

(a) Antimony quotations in cents per pound, for ordinary brands. (b) Quicksilver in dollars per flask of 75 lb. (c) Platinum in dollars per ounce

Pig Iron, Pittsburgh

	Bessemer 1926	Bessemer 1927	Basic 1926	Basic 1927	No. 2 Foundry 1926	No. 2 Foundry 1927
January	22.76	.....	21.76	.....	22.26	.....
February	22.76	.....	21.76	.....	22.26	.....
March	22.76	.....	21.76	.....	22.26	.....
April	21.38	.....	20.66	.....	21.05	.....
May	21.12	.....	19.76	.....	20.76	.....
June	20.76	.....	19.76	.....	19.80	.....
July	20.44	.....	19.26	.....	19.49	.....
August	19.87	.....	19.18	.....	19.26	.....
September	20.11	.....	19.26	.....	19.30	.....
October	20.76	.....	19.76	.....	19.97	.....
November	21.90	.....	20.46	.....	20.96	.....
December	21.26	.....	20.26	.....	20.53	.....
Year	21.31	.....	20.29	.....	20.64	.....

In dollars per long ton.

Monthly Crude Copper Output in Short Tons

Domestic

	1926 June	July	August	Sept.	Oct.	Nov.
Alaska shipments	4,059	2,838	3,093	2,078	3,073	3,769
Butte & Superior	892†	.....	.....	835†	.....	.....
Calumet & Arizona	2,104	1,666	1,960	1,793	2,380	1,833
Magma	1,208	1,345	1,315	1,211	1,198	1,155
Miami	2,241	2,200	2,447	2,251	2,468	2,412
New Cornelia	3,543	3,466	3,194	3,292	3,556	4,227
Nevada Con	27,539†	.....	.....	†29,090	.....	.....
Old Dominion	1,058	985	1,350	797	908	1,127
Phelps Dodge	6,786	6,775	6,723	5,866	5,493	6,638
United Verde Extension	1,908	1,738	1,765	1,756	1,901	1,677
Utah Copper	26,890†	.....	.....	†30,902	.....	.....
Tennessee Copper	521	543	511	499	523	524

Foreign

Boleo, Mexico	1,008	1,106	1,124	898	992	992
Furukawa, Japan	1,323	1,526	1,550	1,532	1,431	.....
Granby Cons., Canada	1,390	1,777	1,805	1,506	1,623	1,626
Union Miniere, Africa	7,294	7,716	8,188	7,623	6,525	7,260
Mount Lyell, Aust	1,695†	.....	.....	†2,182	.....	.....
Sumitomo, Japan	1,364	1,498	1,396	826	.....	.....
Bwana M'Kubwa	.....	.....	.....	195	255	.....

†Three months.

Monthly Production of Primary Copper from U. S. Mines and Daily Rate (Short Tons)

	1924 Monthly Production	1924 Daily Rate	1925 Monthly Production	1925 Daily Rate	1926 Monthly Production	1926 Daily Rate
January	66,631	2,149	74,789	2,412	71,026	2,291
February	65,681	2,265	68,967	2,463	68,131	2,433
March	65,181	2,102	74,901	2,416	75,728	2,443
April	66,073	2,202	70,667	2,356	73,454	2,448
May	65,608	2,116	70,574	2,276	73,542	2,372
June	63,933	2,131	59,894	2,330	71,317	2,377
July	64,787	2,090	68,507	2,210	72,228	2,330
August	66,756	2,153	68,090	2,196	72,014	2,323
September	63,800	2,127	67,720	2,272	72,672	2,421
October	68,989	2,225	71,042	2,292	75,099	2,423
November	68,291	2,276	67,400	2,247	75,240	2,508
December	67,647	2,182	69,566	2,244	.....	.....
Total	793,377	.....	842,117	.....	800,400	.....
Monthly average	66,115	.....	70,176	.....	72,764	.....
Average of daily rate	.....	2,168	.....	2,307	.....	2,396

Mining Stocks—Week Ended January 1, 1927

Stock	Exch.	High	Low	Last	Last Div.
COPPER					
Anaconda	New York	49½	47⅞	48	Ja. 15, Fe. 21 Q 0.75
Arcadian Consol.	Boston	...	...	*45	... ...
Ariz. Com'l.	Boston	10	9¼	9½	Jy. 16, Jy. 30 0.50
Calaveras	N. Y. Curb	2⅜	1⅞	2⅛	... ...
Calumet & Arizona	New York	67⅞	66½	66½	De. 3, De. 20 Q 1.50
Calumet & Hecla	Boston	15⅝	14½	14⅝	No.30, De.15 0.50
Cerro de Pasco	New York	62⅝	61⅝	62	De. 16, De.23, X 1.00
Chile Copper	New York	35	33⅜	34½	De.1, De.27, Q 0.62½
Chino	New York	...	...	25½	... ...
Con. Coppermines	N. Y. Curb	3	2⅞	2⅞	... ...
Copper Range	Boston	14½	14	14½	May, 1926 1.00
Crystal Copper	Boston Curb	*30	*30	*30	... ...
East Butte	Boston	2⅜	2⅜	2⅜	Dec., 1919 0.50
First National	Boston Curb	...	...	*5	Feb., 1919 0.15
Franklin	Boston	...	...	*30	... ...
Granby Consol.	New York	34⅜	33	34½	May, 1919 1.25
Greene-Cananea	New York	32⅝	30	31⅞	Nov., 1920 0.50
Hancock	Boston	...	...	*37	... ...
Howe Sound	New York	41⅞	39⅞	40	Oc.1, Oc.15 Q 1.00
Inspiration Consl.	New York	26	25	25	De.16, Ja.3, Q 0.50
Iron Cap	Boston Curb	3	2⅞	2⅞	... ...
Isle Royale	Boston	10½	10½	10½	No. 30, De. 15 0.50
Jerome Verde Dev.	N. Y. Curb	*30	*30	*30	... ...
Kennecott	New York	62½	61⅜	62	De. 3, Ja. 2 Q 1.25
Lake Copper	Boston	*99	*99	*99	June, 1925 0.50
Magma Copper	New York	35⅜	35	35	Dec. 1, Ja. 15, Q 0.75
Mason Valley	N. Y. Curb	2⅛	2⅛	2⅛	... ...
Mass Consolidated	Boston	...	...	*35	Nov., 1917 1.00
Miami Copper	New York	16⅜	16⅛	16⅛	No.1, No. 15 Q 0.37½
Mohawk	Boston	40	39	39	Oc.30, De.1 Q 2.00
Mother Lode Coa.	New York	4⅜	4⅛	4¼	De.10, De.31 SA 0.37½
Nevada Consol.	New York	15	14⅜	14⅜	De.15, De.31 Q 0.37½
New Cornelia	Boston	22⅜	22	22	No.5, No.22 Q 0.50
Noranda	N. Y. Curb	24	23½	24	... ...
North Butte	Boston	3½	3⅛	3⅜	Oct., 1918 0.25
Ohio Copper	N. Y. Curb	*45	*45	*45	Se. 1, Se. 15 0.03
Old Dominion	Boston	14½	13	14	Dec., 1918 1.00
Phelps Dodge	Open Mar.	†132	†128	...	De.24, Ja.3 Q 1.50
Quincy	Boston	17⅜	16½	17⅜	Mar., 1926 1.00
Ray Consolidated	New York	15⅜	15⅛	15⅛	Ap.20, Ap.30 0.25
St. Mary's Min. Ld.	Boston	26	25	25	May, 1926 2.00
Seneca Copper	New York	3	2½	2⅜	... ...
Shannon	Boston	*20	*20	*20	Nov., 1917 0.25
Shattuck-Denn	Boston Curb	5⅜	5⅜	5⅜	... ...
Superior & Boston	Boston	...	...	*30	... ...
Tenn. C. & C.	New York	11	10⅝	11	No.30, De.15, Q 0.25
United Verde Ex.	N. Y. Curb	24½	24	24	Ja. 6, Fe. 1 0.75
Utah Copper	New York	113	113	113	De.15, De.31 Q 1.50
Utah Metal & T.	Boston	1 1/16	1	1	Dec., 1917 0.30
Victoria	Boston	...	...	*75	... ...
Walker Mining	Salt Lake	*77	*75	*76	... ...
NICKEL-COPPER					
Internat. Nickel	New York	39¼	37	38⅜	De.16, De.31, Q 0.50
Internat. Nickel, pfd.	New York	104½	104½	104½	Oc.14, No.1 1.50
LEAD					
Gladstone Mtn.	Spokane	...	...	*29½	Dec. 10, 1926 0 005
National Lead	New York	174½	165½	167	De.10, De.31 Q 2.00
National Lead pfd.	New York	117½	117½	117½	No.19, De.15 Q 1.75
St. Joseph Lead	New York	41¼	40¾	41½	Ma.10, 21 XQ 0.75
ZINC					
Am. Z. L. & S.	New York	8¾	8½	8⅝	May., 1917 1.00
Am. Z. L. & S, pfd.	New York	46½	43½	44½	Nov., 1920 1.50
Butte C. & Z.	New York	4⅝	4½	4½	De.9, De.24 0.50
Butte & Superior	New York	11½	10½	10⅝	De.9, De.24 Q 0.50
Callahan Zn-Ld	New York	1⅜	1⅜	1⅜	Dec., 1920 0.50
Eagle-Picher	Cincinnati	27⅞	27⅝	27⅝	No.15, De.1 Q 0.40
Eagle-Picher, pfd.	Cincinnati	...	...	100	Se. 30, Oc. 5 Q 1.50
New Jersey Zn.	N. Y. Curb	195	190	193¾	No.20, De.10 X 2.00
United Zinc	N. Y. Curb	55	55	55	... ...
Yellow Pine	Los Angeles	*17	*16½	*17	Dec. 1925 Q 0.04
GOLD					
Alaska Juneau	New York	1¼	1⅛	1⅛	... ...
Argonaut	Toronto	*56	*49½	*53	... ...
Barry-Hollinger	Toronto	*87	*83	*86	... ...
Carson Hill	Boston	...	...	*15	... ...
Consol. W. Dome L.	Toronto	*19½	*17½	*18	... ...
Cresson Consol. G.	N. Y. Curb	2⅜	2⅜	2⅜	De.31, Ja.10 Q 0.10
Crown Reserve	Toronto	*10½	*9	*10	Jan., 1917 0.05
Dome Mines	New York	11⅜	9⅜	9⅜	De.31, Ja.30, Q 0.50
Golden Center	N. Y. Curb	1⅝	1⅜	1⅜	... ...
Golden Cycle	Colo Spring	†1.78	†1.75	...	No.30, De.10 Q 0.04
Hollinger Consol.	Toronto	21.00	19.75	20.50	De.13, De.31 F 0.10
Homestake Mining	New York	61¾	61¼	61¼	De.20, De.27 M 0.50
Kirkland Lake	Toronto	*90	*70	*89	... ...
Lake Shore	Toronto	16.00	14.50	15.60	De.2, De.15 X 0.20
McIntyre-Porcupine	New York	26	25	25	No.1, De.1 Q 0.25
Newray	Toronto	...	...	*33	... ...
Night Hawk Pen.	Toronto	*9	*7	*7	... ...
Portland	N. Y. Curb	†*62	†*57	...	Ja.6, Ja.15, '27 0.02
Rand Mines	New York	...	...	39½	Au.23–30 Am.Sh. 1.52
Teck-Hughes	Toronto	5.60	5.20	5.49	Jy. 15, Au. 2 0.05
Tom Reed	Los Angeles	*51	*51	*51	Dec., 1926 0.02
Tough-Oakes	Toronto	*64½	*51	*62	... ...
United Eastern	N. Y. Curb	*55	*54	*53	July, 1924 0.05
Vipond Cons.	Toronto	1.72	1.61	1.72	... ...
Wright-Hargreaves	Toronto	10.00	9.50	9.90	Ja.15, Fe.1 QX 0.15
Yukon-Alaska Trust	N. Y. Curb	20⅛	20¼	20¼	... ...
GOLD AND SILVER					
Carnegie Metals	Boston	...	...	11⅜	... ...
Con. Cortez	N. Y. Curb	*12	*8	*12	... ...
Con. Virginia	San Francisco	*6½	*5½	*6½	... ...
Continental Mines	N. Y. Curb	*16	*15	*15	... ...
Dolores Esperanza	N. Y. Curb	...	...	*50	July, 1923 0.05
Premier Gold	N. Y. Curb	1⅞	1⅞	1⅞	De.17, Ja.4 Q 0.08
Tonopah Belmont	N. Y. Curb	2⅜	2⅜	2⅜	Se.15, Oc.1 0.05
Tonopah Extension	N. Y. Curb	*20	*18	*18	Apr. 1925 0.05
Tonopah Mining	N. Y. Curb	3⅜	3⅜	3⅜	Se.30, Oc.21 SA 0.07½
West End Consol.	N. Y. Curb	...	...	*8	Mar., 1923 0.05
Yukon Gold	N. Y. Curb	...	...	*40	June, 1918 0.02

Stock	Exch.	High	Low	Last	Last Div.
SILVER					
Beaver Consol	Toronto	*68	*51	*68	May. 1926 0.03
Canadian Lorrain	Toronto	*59	*58	*59	... ...
Castle-Trethewey	Toronto	1.11	1.02	1.06	... ...
Comagas	Toronto	4.35	4.20	4.35	May, 1924 0 1.4
Keeley	Toronto	1.55	1.51	1.51	Se. 1, Se. 15 SA 0.12
Kerr Lake	N. Y. Curb	*75	*75	*75	Oc. 1, Oc. 15 SA 0 12½
La Rose	Toronto	*13	*10	*10	Aug., 1922 0 10½
Lorrain Trout Lake	Toronto	...	...	*55	July, 1925 0.05
McKinley-Dar.-Sav.	Toronto	*14	*12½	*12½	Oct., 1926 0.03
Mining Corp. Can.	Toronto	3.28	3.10	3.10	De.30, Ja.15 0.12½
Nipissing	N. Y. Curb	9¼	8⅜	8⅜	De.31, Ja.20 Q 0.15
Temiskaming	Toronto	*7½	*7½	*7½	Jan., 1920 0.40
SILVER-LEAD					
Ahumada	New York	5⅛	4⅞	5	De.18, Ja.5, QX 0.15
Alta Merger	Salt Lake	†*3	†*2	...	... ...
Bingham Mines	Boston	29⅜	29⅛	29⅛	De.30, Ja.5 Q 1.00
Cardiff M. & M.	Salt Lake	*50	*25	*48	Nov., 1924 0.10
Chief Consol.	Salt Lake	2.90	2.90	2.90	Oc.10, No.1 Q 0.10
Consti'n Mng. & Mill'g	Spokane	...	...	*50	... ...
Emma Silver	Salt Lake	†1½	†1	...	... ...
Erupcion	Boston Curb	1⅜	1⅜	1⅜	De.18, Ja.3, Q 0.10
Federal M. & S.	New York	88	88	88	... ...
Federal M. & S., pfd.	New York	78	76¾	77	No.24, De.15 Q 1.75
Hawthorne Mines	N. Y. Curb	*12	*10	*11	... ...
Hecla Mining	N. Y. Curb	*15⅜	*15⅛	*15⅛	No.15, De.15 Q 0.50
Highland-Surprise	Spokane	...	...	*17	... ...
Iron King Mining	Salt Lake	...	...	*20	... ...
Keystone Mining	Salt Lake	...	...	*30	Au.12, Au.26 0.07½
Lucky Jim	Spokane	...	...	*15¾	... ...
Lucky Tiger-Com.	Kansas City	†6.50	†6.25	...	Dec. 20, 1926 0.12
Mammoth Mining	Salt Lake	2.65	2.65	2.65	De.17, De.23, Q 0.25
Marsh Mines	Spokane	...	...	1⅞	Se.15, Oc.19 0.15
Park Utah	New York	5.95	5.95	5.95	De.15, Ja.2 Q 0.15
Plutus Mining	Salt Lake	2.15	2.05	2.12½	Oct. 15, Q 0.15
Prince Cons.	Salt Lake	*2	*1⅜	*1⅜	... ...
Silver King Coal	Salt Lake	7.80	7.65	7.80	De.16, Ja.3 0.25
Silversmith	Spokane	...	...	*25½	Oc.1, Oc.10 Q 0.02
Strattons Mines	Spokane	...	...	*32	... ...
Sunshine M. Co.	Spokane	...	...	*37	... ...
Tamarack-Custer	Spokane	...	...	*38¾	Sept., 1924 0.25
Tintic Standard	Salt Lake	11.12½	11.00	11.12½	De.11, Ja.3 0.30
Utah-Apex	Boston	6¼	5⅜	5⅜	Oc.3, Oc.15 Q 0.25
IRON					
Bethlehem Steel	New York	48⅜	46½	46⅞	July, 1924 1.25
Cleveland-Cliffs Iron	Cleveland	77	75	76	Oct., 1926 1.00
Colorado Fuel & Iron	New York	46⅜	43	43½	May, 1921 0.75
Gt. North'n Iron Ore	New York	20⅛	19	19⅜	Dec.6, Dec.28 0.75
Inland Steel	New York	43	41½	42½	No.15, De.1 Q 0.62½
Mesabi Iron	N. Y. Curb	95	95	95	... ...
Replogle Steel	New York	11⅞	11	11⅞	... ...
Republic I. & S.	New York	58	56⅛	57½	No.15, De.1 Q 1.00
Republic I. & S. pfd.	New York	97	96½	96⅞	De.15, Ja.2 Q 1.75
Sloss-Sheffield S. & I.	New York	133	127	127	De.10, De.20 Q 1.50
Sloss-Shef. S.&I. pfd.	New York	...	...	107	De.20, Ja.3 Q 1.75
U. S. Steel	New York	160⅛	155⅜	157⅜	De.1, De.30 Q 1.75
U. S. Steel pfd	New York	117	113⅞	114⅜	No.2, No.29, Q 1.75½
Virginia I. C. & C.	New York	...	...	50	Jan., 1924 1.50
Virginia I.C.&C.pfd	New York	80½	80½	80½	De.15, Ja.2, 2.50
DIAMONDS, PLATINUM, ALUMINUM, VANADIUM, TIN					
De Beers Consol.	New York	32⅛	32⅛	32⅛	Ju.16, Ju.17 1.70
So. Am. Gold & P.	N. Y. Curb	4	3⅝	3⅝	... ...
Alum Co. of Amer.	N.Y.Curb	72	71	71	... ...
Alum. Co. of Amer pf.	N.Y.Curb	102	102	102	De.15, Ja.15 Q 1.50
Vanadium Corp.	New York	40	39	40	De.1, De.15, X 1.00
Patino M. & E.	N. Y. Curb	...	...	25¾	Nov. 5, 1926 5 sh
ASBESTOS					
Asbestos Corp., New	Montreal	24	23½	23⅞	Jan., 1926 1.50
Asbestos Corp., pfd.	Montreal	86	84¼	84¾	De.31, Ja.15, Q 1.75
SULPHUR					
Freeport Texas	New York	35⅝	33⅝	34	Ja.15, Fe.1 Q 0.50
Texas Gulf, new	New York	50⅜	48¼	49⅜	De.1, De.15, Q 1.00
MINING, SMELTING, REFINING AND GENERAL					
Amer. Metal	New York	43	42½	42½	No.19, De.1, Q 1.00
Amer. Metal pfd	New York	...	...	113¼	No.20, De.1 Q 1.75
Amer. Sm. & Ref.	New York	149⅜	141½	142⅜	Ja.14, Fe.1, Q 2.00
Amer. Sm.&Ref.pfd.	New York	120⅜	120¼	120¾	Fe.4, Ma.1, Q 1.75
Consol. M. & S.	Montreal	...	...	300	De.31, Ja.15 X 6.25
Federated Metals	N. Y. Curb	12⅝	12½	12½	... ...
Newmont Mining	N. Y. Curb	73	72	73	De.31 Ja.17. 0.60
U. S. Sm. R. & M.	New York	36½	35½	36	Ja.6, Ja.15, Q 0.87½
U. S. Sm. R.&M.pfd.	New York	47½	46⅜	47½	Ja.6, Ja.15, Q 0.87½

* Cents per share. † Bid or asked. Q, Quarterly. SA, Semi-annually. M, Monthly. F, four weeks. I, Initial. X, Includes extra. The first date given is that of the closing of the books; the second that of the payment of the dividend.

Boston quotations courtesy Boston Stock Exchange; Toronto quotations those of the Standard Stock Exchange of Toronto, by courtesy of Arthur E. Moysey & Co.; Spokane, Pohlman Investment Co.; Salt Lake, Stock and Mining Exchange; Henry Sachs, Colorado Springs, Colo.

LONDON QUOTATIONS—WEEK ENDED DEC. 21, 1926

Name	High	Low	Last	Date	Last Div. Amount
Aramayo Mines (25 frs.)	75/3	73/9	75/—	Aug. 1926	15 p.c.†
British Piatinum (£1)	3/4½	2/9	3/—	Feb. 1925	2½ p.c.
Burma Corpn. (10 rupees)	14/4½	13 10½	14/1½	Feb. 1927	6 annas*
Bwana M'Kubwa (5s)	7/1½	6 7½	6/10½		
Camp Bird (2s)	2/6	2/3	2/3		
El Oro (£1)	5/—	4/4½	4/9	Nov. 1924	2½ p.c.*
Esperansa (10s)	—/6½	—/4½	—/6		
Frontino & Bolivia (£1)	12/6—	12/—	12/6	Jan. 1927	5 p.c.
Mexican Corpn. (£1)	8/6—	7/9—	8/6		
Mexico Mines of El Oro (£1)	21/3	19/—	21/3	Dec. 1926	3½ p.c.
N'Changa Copper Mining	14/9	13/—	13/9	... ...	... ...
Oroville Dredging (£1)	3/9	3 4½	3/9	Dec. 1923	3¾ p.c.
Ouro Preto (£1)	2/1½	2 —	2/—	May 1925	2½ p.c.
Rhodesian Congo Border (£1)	80/—	76/3	77/6		
St. John del Rey (£1)	9/1½	8/9	9/—	June 1925	6½ p.c.
San Francisco Mines (10s)	32/—	31/—	31/6	Jan. 1927	25 sd.
Santa Gertrudis (£1)	14/7½	14/—	14/3	Jan. 1927	3½ p.c.
Selukwe (2s. 6d.)	11/7½	11/1½	11/6	April 1917	6¼ p.c.
S. Amer. Copper (2s.)	3/7½	3/3	3/6	Nov. 1917	75 p.c.
Tanganyika (£1)	44/	41/	41/10½	Aug. 1926	7½ p.c.
Tomboy (£1)	3/6	3/3	3/3	July 1926	10 p.c.
Union Miniere du Haut-Katanga (Brussels)	8.450	8.300	8.330	July 1926	175 (‡)

* Free of British income tax. † Swiss frs. ‡ Belgian frs. and free of taxation